SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

JUNE 1902.

GENERAL PHYSICS.

1018. *Gas-Washing Apparatus.* **C. E. Stromeyer.** (Manchester Lit. and Phil. Soc., Mem. 46. 2. pp. 1–3, Feb. 10, 1902.)—In order to gain an increased time of contact between the gas which is under examination and the absorbing liquid, where comparatively large volumes of gas have to be examined, the author devised an arrangement which consists of two bulbs connected by a **U**-shaped circulating tube for the liquid, and by a spiral, which branches off from this tube below the inlet bulb, at a point below the working level of the liquid, and delivers the bubbles of gas downwards in the centre of the outlet bulb, at a point above the level of the absorbing liquid. The gas invariably breaks into bubbles on entering the spiral, carrying forward a certain quantity of the liquid, which drips from the delivery end at the latter point, on the bubbles emerging and bursting, and returns by the circulating tube. In ordinary bulb apparatus, the time of contact between the gas and the absorbing liquid is limited to what is required by each bubble in rising through about 1 in. of liquid. In this new form, the time of contact does not depend on the depth of liquid, but on the volume of gas passed through the coil per second. A satisfactory specimen of the apparatus had a coil 30 in. long and ⅛ in. bore, with a difference of level, between the two points, of 1¼ in. A stream of air passing at the rate of 7 litres per hour was completely broken into bubbles, the estimated duration of contact being 2½ seconds. A larger model having a coil 4 ft. long and ¼ in. bore worked best when about 50 litres per hour were passed through it, giving a period of contact of about 3 seconds. F. J. R.

1019. *Steel Measuring-Tape Apparatus.* **A. E. Burton** and **J. F. Hayford.** (Eng. Record, 45. pp. 80–81, Jan. 25, 1902.)—A brief outline is given of the development of this instrument at the Massachusetts Institute of Technology since 1888, and of the tests to which it was submitted by the U.S. Coast and Geodetic Survey in November, 1900. A 100-m. steel tape, suspended in two catenaries of 50 m., was sometimes applied; this interval is, however, too great in windy weather. With the addition of the thermophone, an improvement introduced by A. E. Burton, which furnishes an instantaneous determination of the actual average temperature of the tape, the instrument is well suited for use even in daylight. H. B.

1020. *Baroscope.* **G. Guglielmo.** (Archives Néerlandaises, 6. pp. 555–562, 1901.)—The author describes various forms of a kind of baroscope. A hollow, but closed sphere of brass, and a solid sphere, of equal weights but unequal volumes, are attached to a balance-beam which, when tilted by the buoyancy of gas lighter than air, will close an electric circuit. In air containing 5 per cent. of CH_4, a sphere of 1 litre capacity would, at ordinary temperature, lose 5 mgrm. of its buoyant force. The same would result, however, if the temperature were to rise by 1° C. or the barometer to sink by 8 mm. To compensate for these effects, the author lets the hollow sphere communicate with the air by a long, narrow tube, or he provides it with a **U**-tube containing a drop of liquid, or he joins a horizontally arranged air thermometer to the beam. Some experiments on the rate of diffusion of illuminating gas through fine tubes are referred to. The apparatus could also be used for demonstrating diffusion, and for other purposes. H. B.

1021. *Small Torsional Oscillations.* **H. Bouasse.** (Journ. de Physique, 1. pp. 21–33, Jan., 1902.)—The author insists strongly on the neglect of experimenters to take account of the mode of variation of torsion with respect to time, and points out the questionable accuracy of the corrections applied in order to eliminate the damping effect of the air. He mentions various sources of experimental error, and points out discrepancies between the results of experiment and theory. Our knowledge of the subject, he says, has increased but very little since the time of Coulomb. [See also Abstract No. 1316 (1899).] W. S.

1022. *Disturbances of a Plumb-bob Suspended on a Steel Wire.* **W. Hallock.** (Amer. Phys. Soc., Bull. 2. pp. 44–45, 1901.) (Abstract.)—During the employment of two plumb-lines, consisting of fifty-pound iron weights, upon steel piano-wire, which were used to establish two points at a depth of over 4,000 ft. in the shaft of a mine, it was noticed that their distance apart was about an inch greater at the bottom than at the top. It is suggested that the divergence might be due to a repulsion of two north magnetic poles formed at the lower ends of the wires by the earth's magnetic field. Observations on iron wires set up by the shaft of the Physical Laboratory of Columbia University confirm the supposition; repulsion was found to occur all along the line between two parallel vertical iron wires. J. J. S.

1023. *Stress and Strain in an Elastic Solid.* **Kelvin.** (Phil. Mag. 3. pp. 95–97, Jan., 1902.)—The author remarks that the method hitherto followed by writers on elasticity has two disadvantages—(1) that the strain is required to be infinitely small; (2) that the specifying elements are of two different kinds, viz., simple elongations, $e\ f\ g$, and simple shearings, $a\ b\ c$. Both faults are avoided if we take for the specifying elements the six edges of a tetrahedron, or the three pairs of face diagonals of a hexahedron.

Cut from the solid a tetrahedon of any shape, A B C D. Let the three non-intersecting pairs of its six edges be denoted by $(f f')$, $(g g')$, $(h h')$. Parallel to A B apply to the faces ADC BDC equal and opposite pulls, uniformly distributed. These two balancing pulls are called a stress component. The same being done for each of the six edges, we have six stress components, P P′, Q Q′, R R′ (2), each parallel to one edge, and these are supposed to be balanced by the mutual forces between the particles of the solid. If $f_0\ f_0'$, &c., are the lengths of the specifying elements when the stress components are zero, the differences between $f_0 f_0'$, &c., in the case of applied forces, represents the strain. If w be the work done when the stresses are increased from zero to (2), we have—

$$w = \mathrm{P}df + \mathrm{P}'df' + \mathrm{Q}dg + \mathrm{Q}'dg' + \mathrm{R}dh + \mathrm{R}'dh',$$

whence $\frac{dw}{df} = \mathrm{P}\,\frac{dw}{df'} = \mathrm{P}'$, &c. This, he says, completes the molar dynamics of an elastic solid of the most general kind. He proposes to apply the method to the dynamics of a crystal, in a communication promised for the Royal Society of Edinburgh. S. H. B.

1024. *Forced Vibrations and Resonance.* **Rayleigh.** (Phil. Mag. 3. pp. 97–117, Jan., 1902.)—A system being defined by n generalised co-ordinates $\psi_1 . \psi_2 .. \psi_n$, the general equations of motion are reduced to a series of equations of the form—

$$\begin{aligned} e_{11}\psi_1 + e_{12}\psi_2 + e_{13}\psi_3 &= \Psi_1, \\ e_{21}\psi_1 + e_{22}\psi_2 + e_{23}\psi_3 &= \Psi_2, \text{ \&c.,} \end{aligned}$$

where e_{rs} denotes the quadratic operator, $e_{rs} = a_{rs}\frac{d^2}{dt^2} + b_{rs}\frac{d}{dt} + c_{rs}$. The coefficients b refer to dissipation of energy. The forces ψ_1, ψ_2, &c., acting on the system, are then assumed to be of the type—

$$\psi = \mathrm{R}\epsilon^{\iota(pt + \theta)}$$

The work done by a single force of this type is calculated. The author deals next with a system of one degree of freedom, with the example of an electric circuit closed by a condenser in which acts a force ψ. If a disposable force ψ' be introduced in another part of the circuit, it does a certain amount of work, the negative of which is work withdrawn from the system. The maximum value of this work is found to be $\mathrm{Mod}^2\Psi/8b$. This theory is then extended to two, and subsequently to more degrees of freedom. In the case of two degrees (two electric circuits) the maximum work that can be withdrawn by Ψ_1 from the system subject to a given force ψ_2 is found to be $\mathrm{Mod}^2\psi_2/8b$, and is independent of the constants of the two circuits.

The author then comes to the action of resonators. The effect is as if the disposable force Ψ introduced does no work on the complete value of the corresponding co-ordinate ψ, though it generally does work on the part of ψ due to itself. The author then introduces the theory given by Lamb's paper, "An Electromagnetic Illustration of the Theory of the Selective Absorption of Light by a Gas" [see Abstract No. 1788 (1900)], in which is developed a general law for the maximum energy emitted by a resonator in a uniform medium under the influence of plane incident waves. Lamb finds that the rate at which energy is carried outwards by the scattered waves is $\frac{2n+1}{2\pi}\lambda^2$, in terms of the energy flux of the primary waves, in which λ is the wave-length, and n the order of the spherical harmonic component of the incident waves. The author discusses this result, and thinks that a yet more general theory is involved in it.

Having thus dealt with the energy emitted by a resonator, the author finally considers the energy stored in resonators when the frequencies of the applied forces are nearly the same as the natural frequency of the resonator.

In the case of one degree of freedom ψ, and a force Ψ, he finds for the energy stored $\frac{\pi}{4b}\text{Mod}^2\Psi$, which is independent of *a* and *c*. Here *a* and *c* are defined by T (kinetic energy) $=\frac{1}{2}a\psi^2$; V (potential energy) $=\frac{1}{2}c\psi^2$. Finally, the case is treated in which the force ψ_2 is of one kind, while ψ, on which resonance depends, is of another. The result here obtained is—

$$\frac{1}{2}c_{11}\int\text{Mod}^2\psi_1 dp=\frac{\pi}{4b_n}\text{Mod}^2\Psi_2.$$

S. H. B.

1025. *Laplace's Capillary Constant.* **G. Bakker.** (Archives Néerlandaises, 6. pp. 758–764, 1901.)—In investigating capillarity we have a choice of two methods, namely, either to consider a system of molecules in motion forming a liquid, or to consider a "homogeneous agent," which produces the same effects in external space as the liquid. In an earlier paper the writer, making use of Van der Waals' theory, proved that the capillary constant satisfies the equation $H=3\mathfrak{Z}-2B$, where $\mathfrak{Z}$ is the work required to separate all the molecules to an infinite distance against their mutual forces, and B is the virial of those forces. In that proof he made use of Euler's integrals. In the present paper he proposes first to prove the same proposition without Euler's integrals, and secondly to give another proof on the hypothesis that the thermic pressure at a given point in the capillary layer is independent of the direction, but without any hypothesis as to the law of force. Any point in the interior of the liquid may be in a homogeneous phase, and for such points $3\mathfrak{Z}-2B=0$. A point within the capillary layer is not in a homogeneous phase, and the above equation does not apply. The author, then, uses Van der Waals' expression for the potential energy, the law of force being derived from $f\frac{1}{r}\epsilon^{-qr}$ as force function, and so works out his first proof. In the second proof he considers a membrane, or lamina of the liquid, in equilibrium under the pressure of its own vapour and two stretched strings at its ends, and if p_1 be the external pressure on an end of the lamina, p_2 the hydrostatic pressure per unit of surface parallel to the surface (*i.e.*, the difference between thermic pressure and cohesion) he obtains the equation

$$H=\int_1^2(p_1-p_2)\,dh$$

the indices referring respectively to the interior liquid and the vapour, and *h* being the direction normal to the surface of the lamina. But if θ denote thermic pressure, and *s* cohesion, $p_1-p_2=s_2-s_1$, because thermic pressure is assumed to be independent of direction, whence we have—

$$H=\int_1^2(s_2-s_1)\,dh$$

By applying Clausius' Virial equation he obtains the result $H=3\mathfrak{Z}-2B$. [See also Abstracts Nos. 762 and 1475 (1901).] S. H. B.

1026. *Seismometer Indications.* **J. Milne.** (Nature, 65. pp. 202–203, Jan. 2, 1902.)—Modern seismometers indicate the time of arrival of the various earthquake phases. If several instruments are differently installed, however, and at some distance apart, only the commencements and the pronounced shocks can be identified, while the instruments may differ as to phases and periods. The first tremors of seismograms, the forerunners, are regarded as elastic waves of compression and rarefaction. With regard to the large waves, following after an interval depending upon the distance from the source, both the horizontal bracket instruments and the spring lever seismographs act as indifferent clinographs; we cannot rely upon their horizontal and vertical components, because the ground for a few hundred miles around an epicentre may be thrown into surface-waves. These surface-waves cannot, however, explain the undulating character of seismograms due to earthquakes at very great distances, which seem to actuate horizontal pendulums by horizontal displacements of the ground rather than by tilting. The author, who refers to some clinograph experiments, C. G. Knott, F. Omori, and W. Schlütter all doubt the surface-wave theory. H. B.

1027. *Seismograph for Strong Earth Tremors.* **G. Agamennone.** (Accad. Lincei, Atti, 11. pp. 116–122, Feb. 2, 1902.)—The author describes, under the name of macroseismometrograph, an arrangement of two horizontal and one large vertical pendulum, for the measurement of earth movements of such intensity as to throw the ordinary instruments out of action. The instrument has been installed at the Rocca di Papa Observatory, after being previously tested on a table to which blows were given, and on a carriage which was run over a mosaic pavement. The seismograms automatically recorded by the pendulums were found to be very satisfactory. While the instrument is in operation, a chronometric arrangement automatically marks the seismogram, so that the time corresponding to any part of the record can be ascertained.

D. H. J.

1028. *Turin Seismographic Records in* 1901. **L. Volta.** (Accad. Sci. Torino, Atti, 37. 5a. pp. 127–142, 1901–1902.)—The macroseismometrograph [see preceding Abstract] installed at Turin in one of the towers of the Palazzo Madama, includes a vertical pendulum consisting of a bob of 200 kilos suspended by a steel wire 24 m. long; the author records in some detail many of the daily tracings of this instrument. In general it is to be noted that there is indication in the seismograms, of much more frequent tremors in the NS. line than in the orthogonal direction; whether this is due to a defect in the suspension of the pendulum has yet to be seen. No very strong shocks were manifest during the year; medium shocks (Grade IV. of the Mercalli scale) were recorded on May 25 and October 30; light tremors (Grade II.) on May 8 and June 24; many slight perturbations were shown on the seismograms. D. H. J.

1029. *Earthquake Movements in the Erzgebirge.* **F. de Montessus de Ballore.** (Comptes Rendus, 134. pp. 96–98, Jan. 13, 1902.)—A description of the distribution of the slight earthquake shocks felt periodically throughout this region is given, and the geological causes are explained. There are about 150 epicentres, of which most are concentrated in the south-west of the Erzegebirge, a region very full of metalliferous veins. These epicentres divide into three well-defined groups, the first with centre at Rotham, the second that of Brambach, and the third, embracing the other two, is the seismic ellipse of Vogtlang. There are also some epicentres of less importance along the Elbe. Of the three kinds of geological phenomena of this kind which exist in the Erzgebirge, viz., regions of fracture, lines of least resistance to volcanic and thermal action, and undulations (*plissements*), only the last has still a considerable action at the present time, and this is shown by the slight tremblings of the earth. J. W. P.

1030. *Transparency and Colour of the Sea.* **J. Thoulet.** (Revue Scientif. 16. pp. 737–741, Dec. 14, 1901.)—The author reviews a book by J. Luksch with the above title, dealing with the observations made by the latter on board the Austrian frigate *Pola* during the years 1890 to 1898 in the Eastern Mediterranean, the Ægean, and the Red Sea. The transparency is estimated by determining the depth to which a disc of sheet iron, painted with lead-white, remains visible; the colour, by comparison with mixtures of solutions of ammoniacal copper sulphate and potassium chromate. Luksch used discs varying in diameter between 36 and 200 cm., and prefers 50 cm. The author prefers, with Secchi, a diameter of 30 cm. The two properties are influenced by the thermometer, wind, altitude of the sun, &c. The transparency is favoured by a blue colour, great salinity and depth of the water, and low temperature; it is least in the summer; for low altitudes of the sun it is in general 33 m. in the Mediterranean, 31 m. in the Ægean, and 21 m. in the Red Sea; the maximum observed was 48 m. Luksch also submerged photographic plates. H. B.

1031. *Climatological Means for Degrees of Latitude.* **W. Bezold.** (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 53. pp. 1330–1343, Dec. 19, 1901.)—By referring the mean values for solar radiation, air temperature, air pressure, cloudiness, and atmospheric precipitations to the sines of the degrees of latitude, instead of to the latitudes themselves, the author obtains instructive climatological curves, either hemispherical, or, by further taking the arithmetical means between the data concerning the two hemispheres, holospherical. The zone between the parallels of mean barometric maxima covers more than half of the globe, while the belt between the temperature maxima is only 0·3 of the surface. The author gives a simple empirical formula for the connection between solar radiation and mean annual temperature; for latitudes between 20° and 50°, this formula agrees as closely with the means of Spitaler and of Batchelder as those two meteorologists agree with one another. Very interesting are also the solar radiation curves for special days. The total annual radiation is found to be equivalent to 300 thermal days, that is, to 300 times the radiation which a point on the equator receives on March 20. Points situated in the belt between ± 37° 9′ lat., which makes up about 0·6 of the surface of the globe, receive more than the mean radiation, points nearer the poles less. The author proposes to designate these degrees of latitude as "mean solar radiation lines." Similarly he speaks of the "mean temperature lines," + 38° 18′ N. lat. and —35° 0·5′ S. lat. H. B.

1032. *Height of the Homogeneous Atmosphere and Mass of the Atmosphere.* **N. Ekholm.** (Öfvers. Kongl. Vet. Akad. Stockholm, Förh. 58. pp. 619–633, Sept. 11, 1901.)—The height H obtained by multiplying the mean height of the mercury barometer by the ratio of the density of mercury to the mean density of air at the level of the sea is termed the *Reduced Height of the Atmosphere.*

The exact height K of the homogeneous atmosphere cannot be calculated, the temperatures of the superior layers of atmosphere being imperfectly known.

Mascart arrived at the result that K differs considerably from H; but the author shows that his reasoning is entirely fallacious, as it would lead to absurdities such as a negative atmospheric pressure at any height greater than 19 km. The ratio K/H is shown to be 1·0056 by reasoning of the same character as that of Mascart, except that his mean error is avoided. When allowance is made for temperature changes, 1·0024 is obtained as the value of the ratio K/H, the excess of K thus being only 0·24 per cent. of H.

Numerical tables of the pressure, density, and mass of air at different heights are given, and the mass of atmosphere is found to be about 0·000000856 of the total mass of the earth. A. G.

1033. *Atmospheric Pressure.* **G. Guglielmo.** (Accad. Lincei, Atti, 11. pp. 70–77, Jan. 19, 1902.)—Apparatus is described for measuring with a water manometer the amount of pressure which it is neccessary to add or take off in order to bring the volume of a given quantity of air to a value corresponding to a known local mean value of the pressure. A. D.

1034. *Observations at High Altitudes.* **J. M. Bacon.** (Soc. Arts, Journ. 50. pp. 169–174; Discussion, pp. 174–175, Jan. 24, 1902.)—The paper deals with observations from balloons and draws attention to various difficulties. The observer may be entirely ignorant of the fact that he has been drifting with changing air currents. Air streams may follow the windings of an estuary or a mountain ridge below; parachutes are frequently diverted by very slender minor air streams, crossing under various angles and ascending or descending. These minor streams make temperature records very unreliable, and hazes often interfere seriously with light and sound; the air may be more charged with dust at high altitudes than in the large towns below. The discussion by **J. Y. Buchanan, H. R. Mill, W. Marriott** and **W. Reid,** concerned chiefly those minor air streams, the ridge of high pressure between two cyclones, the haze and the transmission of sound in cones analagous to detonation cones of blasting agents in rocks. H. B.

1035. *Russian Rainbow Statistics.* **E. Leyst.** (Soc. Imp. Nat. Moscou, Bull. 1. and 2. pp. 102–184, 1901.)—The author regrets that so little attention is paid to rainbows, and that there is no uniform method for recording them. In European and Asiatic Russia, rainbow records have been kept more or less regularly and reliably, since 1875, at sixty-nine stations, for periods varying between seven and twenty-five years. Having examined 13,332 monthly reports, concerning altogether 4,326 rainbows, the author arrives at the following conclusions: There was a minimum number of rainbows in 1887–8, preceded by a secondary minimum in 1884 and followed by a maximum in 1897–8, with a secondary maximum in 1892–3; the maxima and minima differ by about 80 per cent., the highest average number of rainbows for any station per year being 8·8. Inland stations with summer rains had three times as many rainbows as coast stations; the frequency decreases with dry summers, and probably also with higher elevation. The maximum occurs earliest in the year, in June, in the Caspian districts; latest, in September, on the east coast of Siberia and on the Black Sea. In general the afternoon has twice as many rainbows as the forenoon; the opposite holds for the Caspian and Black Sea districts and sea-coasts in general. Noon rainbows have their maximum frequency in September, evening rainbows in the first days of July. H. B.

1036. *Solar Theory.* **R. Emden.** (Astrophys. Journ. 15. pp. 38–59, Jan., 1902.)—The author elaborates a theory of wave-action for explaining the various phenomena of the sun's surface. He concludes that there will be produced, at varying depths below the photospheric surface, regions of discontinuity, about which there will be formed unstable wave-fronts similar to the breaking waves we are familiar with. These may give rise to vortex motion, and so lead to the formation of spots, &c. The periodic and localised nature with respect to latitude of these various phenomena appear to admit of explanation on these assumptions. C. P. B.

1037. *Solar Radiation and Earth Temperatures.* **C. G. Knott.** (Roy. Soc. Edinburgh, Proc. 23. pp. 296–311, July, 1901.)—This inquiry was undertaken in consideration of certain observations in the Mediterranean, which indicated that the direct effect of solar radiation was perceptible to a depth of more than 150 feet, as shown by the daily fluctuation of temperature from 8 a.m to 4 p.m. This would mean an accumulation of heat of about 1,460 calories under every square centimetre of the water surface, and the author considers that this cannot be accounted for (at least if Langley's value of the solar constant be adopted) by simple direct solar radiation. To get some definite data on this point, the energy received was calculated by graphic integration, and tables of the resulting values are given. According to this, and using a solar constant of 3, it is found that in the Mediterranean 950 units of heat would be received on Midsummer Day. This reduced to the epoch of the above-mentioned determinations comes to 730 units. An harmonic analysis is then made of the readings of deep thermometers in the Calton Hill at Edinburgh. These show that there is an excess accumulation of 1,200 units during September compared with that during March. The calculated total excess of energy supplied during summer is 100,000 units, so that some 99 per cent. has escaped again by radiation, convection, or conduction. This is in marked contrast to the result obtained from the ocean determinations, and it is hoped more observations will be made in widely separated regions to elucidate the matter. C. P. B.

1038. *Effective Temperature of the Sun.* **W. E. Wilson.** (Roy. Soc., Proc. 69. pp. 312–320, Jan. 31, 1902.)—The author has repeated his experiments of 1894 with a different radiator for the comparison source of temperature. In the former case a strip of platinum heated by electric means was employed in one arm of the radio-micrometer. This has been replaced by a long porcelain tube, 2 ft. in length and 1 in. diameter, heated to any desired degree in a gas furnace. The radiation from the interior of such a cavity appears to more nearly fulfil the conditions of a perfect radiator. The solar comparison was made as before, using the reflected light from the unsilvered glass plane mirror of the heliostat. The mean effective temperature, using Rosetti's determination of the amount of terrestrial atmospheric absorption, is 5,773° C. If the total loss due to absorption in the sun's own atmosphere be also considered, the value of the temperature would be near 6,590° C. C. P. B.

1039. *Origin of Double Lines in the Spectrum of the Chromosphere.* **W. H. Julius.** (Astrophys. Journ. 15. pp. 28–37, Jan., 1902.)—On the theory previously put forward by the author that the chromospheric light is to a large extent composed of the light from the photosphere which has undergone anomalous dispersion in the absorbing vapours of the sun, it is evident that the wave-lengths of the bright lines of the prominences, chromosphere and flash, cannot be the same as the wave-lengths of the corresponding absorption lines in the ordinary spectrum. Each bright line corresponding to an absorption line of wave-length λ is supposed to be produced by radiations of wave-length $\lambda \pm \delta$. If curves be drawn for the light distribution in a

chromospheric line on this hypothesis it will be found that the lines should be double. The author has found, on examining the photographs taken by the Dutch Expedition during the eclipse of May 18, 1901, that the chromospheric lines are double ; on one plate taken just after third contact, all the lines (150) are double between λ = 3,889 and λ = 4,600. At the same time it must not be forgotten that the chromosphere forms a source of radiations in itself, and it is a question what is the relation between the emitted chromospheric light and the abnormally refracted photospheric light.
E. C. C. B.

1040. *Ultra-Neptunian Planet.* **G. Forbes.** (Roy. Soc. Edinburgh, Proc. 23. pp. 370–374, July, 1901.)—Additional confirmatory data are supplied concerning the probable existence of a planet having an orbit exterior to that of Neptune. The view first announced in 1880 was based on the determination of the Aphelia of seven comets. These have been revised, and new orbits considered, especially of the comet of 1556. The extent of the perturbations produced is so great that the mass of the supposed planet would be greater than that of Jupiter. C. P. B.

REFERENCES.

1041. *The Harmonic Analyser.* **L. Grabowski.** (Akad. Wiss. Wien, Sitz. Ber. 110. 2a. pp. 717–889, July, 1901.)—In this paper the author describes the extremely convenient instrument designed by O. Henrici and constructed by Coradi, of Zurich. The theory and use of the instrument are fully discussed, with the corrections to be applied in its practical employment. G. W. DE T.

1042. *Measurement of Sunshine.* **C. F. Marvin.** (Monthly Weather Rev. 29 pp. 454–458, Oct., 1901.)—The general principles of sunshine registration are described, special attention being drawn to the incomplete record of the black-bulb thermometer. The remainder of the paper deals with the new Angström electric compensation pyrheliometers which are to be used in the meteorological investigations of the Weather Bureau. C. P. B.

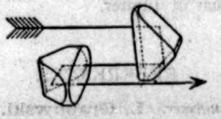
1043. *Sun-spot Period and the Meteorology of Jamaica.* **M. Hall.** (Monthly Weather Rev. 29. pp. 503–504, Nov., 1901.)—Comparisons are given of the mean daily temperature, rainfall, and spotted area of the sun's surface from 1867 to 1897, and curves plotted showing suggestive coincidences among the three phenomena.
C. P. B.

1044. *Photographs of the Corona, May* 28, 1900. **T. Heath.** (Roy. Soc. Edinburgh, Proc. 23. pp. 396–400, Dec., 1901.)—The paper contains descriptions of four photographs of the corona obtained at Santa Pola, on the east coast of Spain, during the total solar eclipse of May 28, 1900. The instrument employed was a Cooke triple objective of 6 in. aperture and 104 in. focal length mounted equatorially. Reproductions from the four photographs accompany the paper, and also a drawing showing the details found in all the negatives. C. P. B.

1045. *New Star in Perseus.* **R. Copeland.** (Roy. Soc. Edinburgh, Proc. 23. pp. 365–369, July, 1901.)—The paper contains brief notes on the first observations made on the new star at the Royal Observatory, Edinburgh, with a sketch of the spectrum seen. C. P. B.

LIGHT.

1046. *Porro Prism Field-Glass.* **W. R. Warner.** (Amer. Soc. Mech. Engin., Trans. 23. No. 926. pp. 813–824; Discussion, pp. 824–826, Dec., 1901.)—A clear account in popular language of this modern form of field-glass, in which the clear definition and large field of the astronomical telescope are obtained without its inconvenient length, by making the rays traverse the tube three times by means of reflecting prisms. The image is also rendered erect by the series of reflections. The idea is due to Porro, an engineer to whom a patent was granted by Napoleon III. about fifty years ago, but the glasses of the day were too imperfect for the purpose. The credit of first applying the principle belongs to Professor Abbe, of Jena. In his instrument, known as the Zeiss, the prisms are made of one of the new Jena glasses, a boro-silicate crown, and only absorb 4 per cent. of the light. The pupillary distance can be adjusted. An American model was brought out by Warner & Swasey two years ago, and the design has been freely copied by other manufacturers. While the magnifying power of the old Galilean type field-glasses was 4 or 5 diameters, that of the new, but a fraction of their size, is 6–10, with much more extensive field. It has been alleged that placing the objectives an inch wider apart than the eyes imparts a stereoscopic effect. The author has investigated this claim by means of a special instrument with movable objectives, and declares it to be untenable, observers having been misled by the improvement in definition. A. E.



1047. *Modern Lighthouse Lamps.* **J. A. Purves.** (Feilden, 6. pp. 121–128, Feb., 1902.)—The multiplication of lighthouses round our coasts has required a multiplication of distinctive signals without, at the same time, decreasing the power of the beam emitted. A description is given, with illustrations, of recent developments in systematic signalling apparatus. Bourdelle's mercury trough, introduced in 1890, allowed rapid revolution and the employment of beams of greater power, the so-called *feux éclairs*. A spindle eclipser designed by the writer is described. It consists of a dioptric panel 180° in azimuth and altitude, a dioptric mirror occupying the other 180° of azimuth. A good oil lamp is placed at the focus and the apparatus can revolve. Any group-flashing signal is then obtained by a suitable design of eclipser.

G. E. A

1048. *Carmen Opaque Projector.* (West. Electn. 30. p. 125, Feb. 22, 1902.)—An optical instrument adapted for projecting the image of any object up to a size of 12 in. by 14 in. by 2 in., whether opaque or transparent. The object is clamped to a shelf, strongly illuminated by two arc lamps of 700 c.p. each, and an image formed with a magnification of 10 diameters. G. E. A.

1049. *Reflecting Power of Metals for Infra-red Rays.* **E. Hagen** and **H. Rubens.** (Zeitschr. Instrumentenk. 22, pp. 12-54, Feb., 1902. Communicated by the Physikalisch-Technischen Reichsanstalt.)—A former paper [see Abstract No. 452 (1902)] is repeated, with the addition of some more tables. The method is then extended to measure reflecting power for infra-red rays. The application of the comparative method employed is shown to be allowable since the achromatism of the projecting system of quartz-fluor-spar is found to be sufficiently perfect between the limits 186 μμ and 1,500 μμ. A Nernst glowing strip was substituted for the arc lamp. Improved values are given for the reflecting powers of old silver, steel, and copper, and the following powers are given in percentages of the incident radiation :—

For λ =	700	800	00	1,000	1,200	1,500 μμ
Freshly cleaned silver	94·6	96·3	—	96·6	—	98·4
Old silver	—	91·6	—	94·4	97·1	98·5
Platinum	69·0	70·3	73·6	75·5	77·7	79·0
Nickel	68·8	69·6	71·6	73·5	76·5	81·4
Steel (unhardened)	57·6	58·0	—	62·3	67·8	71·9
Gold	92·3	94·9	96·4	97·1	97·6	97·3
Copper (purest commercial)............	83·4	88·6	91·6	93·0	95·1	94·5
Rosse's alloy................................	66·8	71·5	74·1	74·6	75·4	76·5
Schroeder's alloy No. 1	67·2	71·5	73·2	74·9	76·1	76·5
Schroeder's alloy No. 6	69·4	74·5	7·49	76·0	76·1	77·0
Mach's magnalium	83·3	84·3	—	84·1	—	83·6
Brandes-Schünemann alloy	54·9	63·1	—	71·3	—	80·9

The table from which the above is taken contains all the values found for these metals from 251 μμ to 1,500 μμ, and for electrolytic copper from 450 μμ to 700 μμ. Reflection is much more uniform for infra-red than for visible and ultra-violet rays. G. E. A.

1050. *Reflection Fringes Formed by Silvered Surfaces.* **M. Hamy.** (Comptes Rendus, 134. pp. 443–446, Feb. 17, 1902.)—Two silvered glass surfaces, very truly plane, are capable of being rendered very truly parallel by means of a special contrivance. One surface is fully silvered, the other surface, N, facing it, is thinly silvered, and forms the plane side of a plano-convex lens, whose remote focus is F. Two kinds of fringes are obtained by reflection, which are stated to be very bright, and suitable for the separation of close radiations even when faint. To obtain those of the first kind the reflecting surfaces are placed at a small angle, and the incident light passes through one-half of a circle described about the point F, with radius less than that of the pupil. They are observed without an eyepiece by placing the eye opposite the other half of the circle. In the case of the second kind of fringes, the light is reflected towards the lens by means of a totally reflecting prism placed at the focus F. When the light fills the faces containing the right angle, the fringes may be seen, localised in the focal plane, in the image of the prism formed by auto-collimation. They assume the form of arcs of circles, with F as centre. The appearance varies with the reflecting power of N. When this is about 0·8 the maxima are very spread out, and the minima are exceedingly fine dark lines. A. E.

1051. *Effect of Refraction on Observations with Vacuum Tubes.* **E. Goldstein.** (Deutsch. Phys. Gesell., Verh. 4. 2. pp. 4–12, Jan. 24, 1902.)—Attention is drawn to the fact, that if the gaseous particles in a tube are rendered luminous, the interior of the tube is seen illuminated, but if the inside wall of the glass becomes luminous, *e.g.*, by phosphorescence, the light appears to come from the outer surface of the glass. E. Wiedemann found (1880) that the outside was luminous in wide tubes and the inside in narrow ones. It is asserted that illumination of the interior wall is, within limits, always accompanied by the appearance of light on the outside of the glass. This appearance is shown to be an optical illusion depending on total reflection and on the relation between internal diameter of tube and thickness of glass. It exists so long as the thickness is equal to or less than half the internal radius, and observations with tubes in which this relation had different values verified this calculation. Also the light (blue, red, &c.) from phosphorescent material affixed to the interior of the tube appeared to come from the outer surface. Canal rays can thus be distinguished from ordinary kathode rays since the gold-yellow light due to the former proceeds from the inner side of the glass, while the light from kathode rays appears to come from the outer surface.

G. E. A.

1052. *Refractive Index of Liquids at Low Temperatures.* **G. Kučera** and **C. Forch.** (Phys. Zeitschr. 3. pp. 132–134, Jan. 1, 1902.)—It has already been shown that the dielectric constant of a liquid decreases with the temperature, in such a way that at the temperature of liquid air Maxwell's law connecting it with the refractive index is very approximately obeyed for all substances hitherto investigated, the substance at that temperature being, of course, a solid. The manner in which this decrease takes place is, however, very different for different substances, some showing first a maximum before the decrease occurs, *e.g.*, CS_2. Alcohols, on the other hand, show a continuous decrease. It therefore becomes interesting to study the temperature variation of the refractive index. The liquid is enclosed in a prism whose refracting edge is horizontal; by this means the surface layer of the substance under examination forms one face of the prism. It is then enclosed in a freezing mixture, solid CO_2 and ether, and its refractive index measured by a total reflexion method. While the spectrometer is being set, another observer takes the temperature by means of a platinum thermometer. The results show that the refractive index, n, may be calculated from formulæ of the form $n = a + bt + ct^2$, where for alcohols a varies between 1·34 — 1·42 and b from 0·00046 — 0·000596. For CS_2—$n = 1{\cdot}64362 - 0{\cdot}000733t + 0{\cdot}000009t^2$.

R. S. W.

1053. *Nature of White Light.* **M. Planck.** (Ann. d. Physik, 7. 2. pp. 390–400, Feb., 1902.)—The author considers that the two apparently contradictory views of Gouy and Carvallo [see Abstract No. 2085 (1901)] may not be fundamentally incompatible. It is unprofitable to begin by examining the source of light, since whatever differences may exist in the individual oscillators are removed by mutual absorption and internal reflection. Further, the energy of a single partial or sine vibration is, like that of a single gas molecule, too small to be perceived alone. An unjustified assumption is made if it is considered that the mutual effect of partials of sufficiently near frequency would be to cause visible interference phenomena. The necessary part is not the existence of interference of partials but the regularity of it. The interference of two rays in the same pencil is then treated mathematically, and the results are summed up as follows: Normal white light of constant intensity is completely defined (1) by the energy distribution in the various parts of the spectrum, (2) by the law that, within a small part of the spectrum in which the energy distribution may be considered uniform, the energies and phase constants of the single simple periodic partials into which the light vector can be broken up are absolutely irregular. If the second law is applied directly to the whole spectrum, the laws of probability give a quite definite distribution as the most probable, and this is the distribution actually found by Paschen, Lummer, and others. [See also Abstract No. 1250 (1900).]

G. E. A.

1054. *Curvature of Retinal Images, taking into Account the Laminated Structure of the Crystalline Lens.* **A. Gleichen.** (Deutsch. Phys. Gesell., Verh. 4. 2. pp. 13–24, Jan. 24, 1902.)—The author adopts for the lens the law of index found by Matthiessen, of Rostock [see "Beiträge zur Dioptrik der Krystallinse," Wiesbaden, 4 Folgen.], and expresses regret that Matthiessen's valuable labours have met with so little recognition. If y be the distance of a point P on the axis of the lens from the kernel, b the value of y at the surface, we have $n = \alpha - \beta(y/b)^2$, where $\alpha = 1{\cdot}4100$ and $\beta = 0{\cdot}0850$. The radius of curvature r of the lamina through P varies as y. In the investigation of the curvature of the image, the object is assumed to be a surface of revolution about the optic axis, and the calculations are based on Petzval's theorem published in 1843. If we have a system of lenses in contact, and the object be a plane at right-angles to the axis, the radius of curvature R′ at the vertex of the image is given by $\frac{1}{\mathrm{R}'} = \Sigma \frac{1}{n_k f_k}$, where $\frac{1}{f_k} = (n_k - 1)\left(\frac{1}{r_k} - \frac{1}{r_{k+1}}\right)$, r_k, r_{k+1} being the radii of the surfaces of the kth lens. A portion of the paper is occupied by a historical discussion of this theorem, which is nearly satisfied by most anastigmatic photographic objectives. It applies in all cases where the aperture of the diaphragm is far from being a point, as in the eye, the diameter of the pupil varying from 5 mm. to 8 mm. The author obtains the following formula from his calculations :—

$$\frac{1}{\mathrm{R}} - \frac{1}{n_0 \mathrm{R}'} = \frac{1}{r_0}\left(1 - \frac{1}{n_0}\right) + \left(\frac{1}{r'_1} - \frac{1}{r_1}\right)\left(\frac{1}{n_1} - \frac{1}{n_0} + \mathrm{K}\right)$$

R, R′ being the radii of curvature of object and image, r_0 the radius of the cornea, r_1 and r'_1 the radii of the anterior and posterior surfaces of the lens, n_0 the index of the vitreous humour, n_1 of the outermost coat of the lens, and K a constant depending only on α and β above. Mathiessen gives the value 1·3750 for n_1, and according to Helmholtz $r_1 = 10$ mm., $r'_1 = -6$ mm. when the eye is accommodated for distant vision, and $r_1 = 5$ mm., $r'_1 = -5$ mm. for near vision. These values give $\frac{1}{\mathrm{R}} - \frac{1}{1{\cdot}335\mathrm{R}'} = 0{\cdot}0475$ for distant vision, and 0·0576 for near vision. If the object be plane, *i.e.*, $\mathrm{R} = \infty$, then we get $\mathrm{R}' = -15{\cdot}7$ mm. for distant and $-18{\cdot}0$ for near vision. Thus the image is not plane, but has nearly the curvature of the retina, though the difference of radius, 2·7 mm. for near and distant vision, seems large. Further, straight lines in the object system give, not straight lines, but circular arcs in the image system. The author remarks that our knowledge as to the process of accommodation is incomplete. Nagel [see "Handbuch der gesammten Augenheilkunde," Graefe & Saemisch, pp. 461, 472] has found that there is an increase of pressure at the back of the eyeball and a relaxation at the front. Possibly this may cause slight increase in curvature of the retina as the object regarded approaches nearer.

A. E.

1055. *The Michelson-Morley Experiment.* **W. M. Hicks.** (Phil. Mag. 3. pp. 9–42, Jan., 1902.)—In this paper the author considers in detail the theory of this experiment, which is complicated by the changes produced by actual reflection at a moving surface. The correction due to alteration in the angle of reflection was pointed out by Lorentz, and allowed for in the case of the joint experiment. Reflection, however, also produces a change of wavelength, and the angle of incidence varies by a small quantity of the first order as the direction of drift of the apparatus changes. These corrections are made in the present paper. As it did not appear legitimate to assume beforehand that the ratio of the velocity of the earth through the ether to that of light is extremely small, the general theory is worked out without approximation, and is found to be comparatively simple. The principal result of the correction is that the effect to be expected is the reverse of what had hitherto been supposed. An examination of Michelson and Morley's numerical results in the light of the complete theory leads to the important result that, in place of giving a null result, there is distinct evidence of an effect of the kind to be expected. The suggestion of G. F. Fitzgerald, put forward to explain the supposed null result, that the motion of a solid through the ether produces a small extension perpendicular to the direction of drift, and a contraction in this direction, is required by the theories of Lorentz and of Lummer as to the relations between matter and ether. In the light of the present complete theory, this contraction would increase instead of annulling the displacement to be observed. The author finally shows that a suitable modification of the experiment will enable the question of the existence of such a contraction to be determined, and if it exists, will make it possible to measure it. G. W. DE T.

1056. *Theory of Fluorescence.* **W. Voigt.** (Archives Néerlandaises, 6. pp. 352–366, 1901.)—The formulation of a complete theory of fluorescence and phosphorescence on the basis of the electron hypothesis is at present impossible, owing to our want of knowledge of the internal constitution of molecules. All that is possible at present is, by the aid of known experimental results, to obtain certain generalisations of the ordinary dispersion equations of the electron theory. The author considers that the experimental evidence warrants the conclusion that these phenomena are due to irregular vibrations arising as a consequence of, but not directly excited by, the incident light. The free negative electrons would be greatly more susceptible to such excitation than the far more massive ponderable portions of the molecules, which, on the electron theory, are associated with the positive electrons. It might be assumed, therefore, that the latter are indirectly set in vibration by the action of the former. Another hypothesis, which the author considers as being, on the whole, more in accordance with the observed phenomena, is that the molecules of a fluorescent substance are capable of existing in two or more distinct states, to which correspond distinct intrinsic periods of the electrons.

The passage from one state to another is assumed to be conditioned (as in the case of a partly dissociated gas) by purely molecular circumstances. In such a medium, if there is sensibly less damping in the state corresponding to the longer period of the electrons, there will in this state be sensible fluorescence, and in the other sensible absorption. The paper concludes with an investigation, on this hypothesis, of the dispersion equations in the case of crystals with three mutually perpendicular axes. G. W. DE T.

1057. *Photographic Apparatus for Analysis of Lightning.* **B. Walter.** (Phys. Zeitschr. 3. pp. 168–171; Discussion, pp. 171–172, Jan. 15, 1902. Paper read before the 73rd Naturforscherversammlung at Hamburg, Sept. 26, 1901.)—A brief discussion of the conditions to be fulfilled by the apparatus used. R. S. W.

1058. *Asymmetry of Zeeman Effect.* **G. W. Walker.** (Phil. Mag. 3. pp. 247–251, Feb., 1902.)—An investigation is given accounting for asymmetry as a second order term arising from the magnetic field. The theory requires that the component towards the violet should have the greater displacement, in this respect agreeing with Voigt's theory, but it differs from Voigt's theory in that it requires the asymmetry to increase with the strength of the magnetic field. According to both theories, too, the actual difference of displacement, other things being equal, is greater at the red end of the spectrum; but the asymmetry is a greater fraction of the separation at the violet end, according to Voigt, at the red end according to the present theory. It might also account for certain lines not being resolvable, but slightly shifted towards the violet. W. E. T.

1059. *Errors in Ruling Diffraction Gratings.* **H. S. Allen.** (Phil. Mag. 3. pp. 92–95, Jan., 1902. Paper read before Section A of the British Association, Sept. 17, 1901.)—Errors made in the ruling of a grating cause the appearance of bands, which are seen by focussing the telescope nearly on the surface of the grating. Two cases are considered in which images are formed by a grating, the two halves of which are ruled to different pitches. Two overlapping beams are thus produced which form focal bands. In the gratings examined the principal error was periodic. A change in the bands from bright to dark, as the telescope is focussed in or out, depends on the sequence of the wide and narrow rulings. G. E. A.

1060. *The Use of Stationary Capillary Waves as Diffraction Gratings, and the Surface Tensions of Water and Mercury.* **A. Kalähne.** (Ann. d. Physik, 7. 2. pp. 440–476, Feb., 1902.)—The velocity of waves on the surface of a liquid is given by the equation, due to Kelvin, $v^2 = \frac{g\lambda}{2\pi} + \frac{2\pi a}{\lambda\sigma}$, a denoting the surface tension, and σ the specific gravity. Transposing, and writing $n\lambda$ for v, we get $a = \lambda^3 n^2 \sigma/2\pi - g\lambda^2\sigma/4\pi^2$. When λ lies below a certain value, the second term is small compared to the first [owing to the largeness of n^2], and in this case the wave-length depends mainly on the surface tension. It is with these short waves, designated capillary by Kelvin, that the paper deals. The stationary waves are obtained by allowing two needles in connection with an electrically driven tuning-fork to dip into the liquid. By utilising this stationary system as a reflection grating, the wave-length, *i.e.*, grating interval, can be determined with great accuracy. Then, λ and n being known, the surface tension is obtained from the above formula. In the case of water at 18° C., in contact with moist air, the author finds $a_{18} = 73{\cdot}77$ dyne/cm. For mercury, the surface tension was found not to be constant, but to diminish with time—a result in accordance with well-known experiments. The highest value obtained by the author was 482 dyne/cm. at 18° C.

In performing the experiments, a sodium flame served as source, the rays falling at an incidence of about 80° on the middle part of the wave-system. As the grating interval was large, about 1 mm., the diffraction angle for the 1st order spectrum was only 10′, and refined apparatus was therefore necessary to obtain an accuracy of 1 in 1,000. A very good goniometer was used, the axis of which could be placed vertically. The frequency of the tuning-fork was 510. The corrections due to the fact that the lines of the grating are not straight, but portions of confocal hyperboles, and to various other sources of error are discussed at length. A. E.

1061. *Spectra of Interference Bands.* **A. Cornu.** (Archives Néerlandaises, 6. pp. 598–606, 1901.)—The difficulty, noted by Fresnel, of distinguishing the central white fringe is explained, starting from a previous conclusion (Comptes Rendus, 1881) that in a system of interference bands produced by means of a heterogeneous light having a continuous spectrum, there always exists an achromatic fringe which takes the place of the central fringe, and which is found at that part of the field where the most intense radiations present a maximum or minimum phase difference. The bands are observed in a spectroscope with the slit normal to the direction of the bands. The case is analysed in which two parts of a ray traverse equal thicknesses, e, of two media, pass normally through two slits $2a$ cm. apart and form bands. The phase difference is then $\phi = y(2ax/\mathrm{D} + \alpha + \beta y)$, where y is $1/\lambda$, x the lateral displacement of the band, D its distance from plane of slits, and α and β are constants equal to ea and eb respectively. The two media have a difference of refractive index expressed by $n' - n'' = a + by + cy^2$. The first equation represents a family of hyperbolæ with common centre and asymptotes. Now if a spectroscope were made in which the deviation could be expressed by $u = u_0 + hy$, u_0 and h being constants, the sheaves of bands seen under above conditions would be hyperbolæ, and the value of y could be found from $y = (u - u_0)/h$, h being the distance of the fringe along the slit. The hyperbolæ have a horizontal asymptote and an oblique one, the latter being formed by a straight bright band. There is also an achromatic band corresponding to $\partial\phi/\partial y = 0$. The tangent which touches the hyperbola $\phi = \mu$ determines the achromatic, or apparently central, fringe. The point where the y axis is cut by the oblique asymptote is called the characteristic point, its distance from the origin being $y_0 = -\frac{a}{b}$. It is deduced that when the characteristic point is on the negative side of y, a and b have the same sign, and the achromatic fringe is further from the origin than the fringe of no phase difference, and the apparent displacement of the central fringe is greater than the displacement calculated from $\phi = 0$ (case of quartz cut parallel to axis). When the characteristic point is at infinity, observation agrees with calculation (gypsum cut in cleavage planes). If the characteristic point is on the positive side of y, the apparent observed displacement is less than the calculated one (topaz cut along cleavage planes). When the characteristic point coincides with the origin, the law of dispersion reduces to $n' - n'' = by$. This holds when the fringes are obtained by means of a biquartz, when the calculated displacement is half the observed. To verify the above theory a spectroscope was made in which (1) the prism is composed of two prisms of crown and one of flint glass; (2) the collimator slit is slightly curved to make the spectrum rays straight all over the field; (3) the objectives of the collimator and telescope are replaced by concave mirrors to avoid deformations due to imperfect achromatism; (4) observations are made photographically with plates made orthochromatic by an erythrosine bath. With this apparatus, using two plates of topaz, the displacements, for yellow light, of the apparently central band and that corresponding to $\phi = 0$ were 35 and 44 bands respectively, these numbers agreeing with Fresnel's. G. E. A.

1062. *Radiation from Mixtures of Chlorides of Radium and Barium.* **T. Tommasina.** (Comptes Rendus, 133. pp. 1299–1301, Dec. 30, 1901.)—The author here proves that such radiations experience reflection. A concave parabolic mirror of silvered copper was employed in conjunction with a Curie electroscope. The salts were contained in a small tube placed at the focus of the mirror and distant 65 cm. from the upper disc of the electroscope. The mirror had a focal distance of 25 mm. and an aperture of 12 cm. The radiation being thus directed upon the electroscope, readings of the leakage were taken at intervals of a minute with the mirror present and absent. In the former case the rate of leakage is about double, showing the action of reflected rays. A further contrivance by which the action of secondary radiations from the mirror surface is eliminated is described, and thus the action is reduced to one of pure reflection. J. W. P.

1063. *Transmission of Excited Radio-activity.* **E. Rutherford.** (Amer. Phys. Soc., Bull. 2. pp. 37–43, 1901.) (Abstract.)—The excited radio-activity produced by thorium compounds is intimately connected with the power of giving off a radio-active emanation. The emanations from thorium and radium behave like radio-active gases or vapours. They diffuse rapidly through gases, through porous substances like cardboard, and, unlike the gaseous ions which they produce in their path, pass through plugs of cotton-wool and bubble through solutions with no absorption. The author considers that these emanations are in some way the direct cause of excited radio-activity. The following facts support this view: (1) Only the substances which emit emanations have the power of exciting radio-activity. (2) If the emanating power of thoria or radium is partly destroyed by strongly heating, the power of exciting radio-activity diminishes in like ratio. (3) Excited radio-activity can be produced in substances if the emanation and not the radio-active substance is present. On the other hand, the power of exciting radio-activity by the radio-active substance itself is very greatly diminished by a current of gas passed over it, which carries away the emanation. The characteristic property of excited radio-activity is that it can be confined to the kathode in a strong electric field. It is probable, therefore, that the radio-activity is due to the transport, in the electric field, of positively charged carriers of some kind. The experiments described support this view, and show that the carriers travel in an electric field with about the same velocity as the positive ion. The method employed to determine the velocity of the carrier is a modification of one already used in a determination of the velocity of the negative ion produced at the surface of a metal by ultra-violet light. It depended on the use of an alternating electric field. A direct p.d. was commuted by means of a revolving commutator into an alternating p.d. of known frequency. If such an alternating field is applied to two parallel plates between which a radio-active emanation is kept uniformly distributed, equal amounts of excited radio-activity are produced in each electrode. If, in series with an alternating p.d. $= E_0$, a battery is placed of e.m.f. E, less than E_0, the positive carrier moves in a stronger electric field in one half alternation than in the other. A carrier consequently moves over unequal distances during the two half alternations, since the velocity of the carrier is proportional to the strength of the electric field in which it moves. Thus the excited radio-activity will be unequally distributed over the two electrodes. If the frequency of alternation is sufficiently great only the positive carriers within a certain small distance of one plate can be conveyed to it, and the rest, in the course of several succeeding alternations, are carried to the other plate.

Assuming that the carriers are produced at a uniform rate at each point between the plates, and that no carriers disappear by recombination, it can be shown that the velocity of the carrier is given by the equation :—

$$K = \frac{2(E_0 + E_1)}{E_0(E_0 - E_1)} \cdot \frac{d^2}{T} \cdot \rho,$$

where d = distance between the parallel plates ; T = time of a half alternation ; ρ = ratio of the excited radio-activity on the plate which has less, to the sum of the radio-activity on both plates. In the experiments the values of E_0, E_1, d, and T were varied, and the general results were in agreement with the equation. For experiments on thoria emanation a thick layer of thoria was placed in a shallow copper vessel inside an ebonite box, 11 cm. square and 3 cm. deep, which was tightly waxed down to a metal base. The thoria was completely covered with two layers of filter-paper, which cut off most of the direct radiation, but readily allowed the emanation to pass through. The apparatus was rendered air-tight by a metal lid dipping into a mercury trough round the top of the ebonite box. At the beginning of an experiment a square sheet of aluminium-foil was placed over the paper covering the thoria, a zinc plate on top of the ebonite box, and the lid placed in position. This was done as quickly as possible, and the alternating electric field was then applied. The emanation rapidly diffused through the paper and thin aluminium-foil, and distributed itself between the plates in the electric field. After an interval, varying in the experiments from 20 to 90 minutes, the aluminium and zinc were removed, and their radio-activity tested in the usual way by a delicate quadrant electrometer. The ratio of the excited radio-activity on the two exposed plates was thus determined. This ratio was found to be independent of the time the plates were left before testing, as the radio-activity on each plate decays at the same rate. The values found for K, expressed in cms. per second for a potential gradient of 1 volt per cm., varied with different voltages and distances between the plates from 1·17 to 1·7. Temperature 18° C. Air fairly dry.

It appears as if the value of the velocity of the positive carrier of excited radio-activity is the same or not very different from the velocity of the positive ion produced in gases by Röntgen or Becquerel rays. In a recent determination Zeleny (Phil. Trans. Roy. Soc. 1900) found the velocity of the positive ion to be 1·36 cm. per second for a potential gradient of 1 volt per cm. at atmospheric pressure and temperature. [See also Abstract No. 2420 (1900).] J. J. S.

1064. *Radio-activity of Thorium.* **K. A. Hofmann** and **F. Zerban.** (Chem. News, 85. pp. 100–101, Feb. 28, 1902. From Berichte Deutsch. Chem. Gesell. Feb., 1902. Communication from the Chemical Laboratory of the Royal Academy of Science at Münich.)—It was found that thorium oxide, obtained from the minerals bröggerite, clèveite, and samarskite, which at first was strongly radio-active, lost its activity after being kept for some months. This appears to indicate that thorium oxide possesses only an induced radio-activity. The authors suppose that the thorium which they prepared acquired its activity from uranium, which is always present in the minerals used. They found that thorium preparations from a Brazilian monazite sand free from uranium were quite inactive immediately after their separation. Moreover, inactive thorium ore thus obtained became strongly radio-active after it had been left for a long time in contact with feebly active uranium. Thorium obtained from minerals containing a large proportion of uranium was found to be strongly active; that got from various minerals with a small percentage of uranium was feebly radio-active. J. J. S.

1065. *Radio-active Lead.* **F. Giesel.** (Chem. News, 85. pp. 89–90, Feb. 21, 1902. Berichte Deutsch. Chem. Gesell., Jan. 18, 1902.)—Giesel prepared 8 mgr. of an intensely radio-active substance from 2,000 kg. of uranium ore. It behaved like lead and also exhibited strong radiation a year after. Demarçay found that the HCl solution of this substance gave a spectrum showing that lead was the predominating element, and that traces of Ca, Ba, Sr, Cr, Al, Mn, Bi, and Sn were present, besides Mg and Fe in particular. Two very weak lines, λ3659·6 and λ4116·8, were not identified, and the radium lines were totally absent. The lines are therefore due either to a new substance or to lead made radio-active by radium. A number of reasons are given to show that Hofmann and Strauss's claim to have discovered a radio-active body closely allied to lead is not upheld by their experimental work. [See also Abstract No. 1889 (1901).] G. E. A.

1066. *Conductivity produced in Dielectric Liquids by the Rays from Radium.* **P. Curie.** (Comptes Rendus, 134. pp. 420–423, Feb. 17, 1902.)—The author finds that the rays from radium and the Röntgen rays act on dielectric liquids as on air and communicate to them a certain electric conductivity. Results of the same order of magnitude were obtained with both these kinds of rays. The current produced through air when rendered conducting increases proportionally to the potential difference when this potential difference is small. When, however, it is increased the strength of the current no longer increases in proportion. Dielectric liquids behave in a similar way, but the current remains proportional to the potential difference up to a limit which is much higher than in the case of gases. J. J. S.

1067. *Röntgen Rays.* **W. Rollins.** (Elect. Rev. N.Y. 40. p. 12, Jan. 4, 1902.)—A method is described of adjusting the character of a tube by electrically heating a substance contained in the tube, for example, potash, and regulating the temperature of the platinum wire which heats that substance so as to adjust the balance between the emission of particles (*e.g.*, water vapour) from that substance and their reabsorption by it. A. D.

1068. *Destructive Ulceration produced by Röntgen Rays. Treatment by Red Rays.* **P. Bar** and **Boullé.** (Revue Int. d'Electrothérapie, 11. pp. 321–329, Nov. and Dec., 1901.)—An application of Röntgen rays was made to the abdomen of a woman for the relief of pain. It lasted twenty minutes; the tube was 6 in. from the skin. Eighteen days later a red blush became visible at that part. It ran a course of two or three weeks, became slightly ulcerated, and healed up. Two months after the exposure to the rays it broke down anew and gradually a large ulcerated surface formed, which was sloughing in the centre and refused to heal. Five months after the exposure to the Röntgen rays, an injection of saline solution was made at a distance of several inches from the margin of the ulcer, and this became the focus of a second extensive slough and ulceration. Treatment eventually was tried by exposure to red rays. The trunk and hips of the patient were enclosed in a box with a window of red glass. This was so adjusted that sunlight could shine upon the ulcerated surfaces through the red glass, and the patient was so arranged in a sunny room that the sun's rays could fall upon her for the greater part of the day. Healing soon commenced, and was complete in less than two months. The injections of saline solution were performed on account of the condition of health of the patient, who had recently been confined. They were repeated five times, four times in the thighs and once in the abdomen. Only the injection into tissue which had been exposed to the Röntgen rays proved disastrous, no doubt by reason of the changed condition of nutrition in that part. The authors cite another case to show that Röntgen ray exposures leave behind them a special vulnerability of the tissues. A man visited a thermal station six months after exposure to a treatment by Röntgen rays. He was treated there by douches of hot water in the customary manner, but the second application provoked ulceration in the part which had been subjected to Röntgen rays, and the ulceration took six months to heal. L. J.

1069. *Accidents caused by Röntgen Rays.* **Oudin.** (Annales d'Électrobiologie, 4. pp. 453–469 and 5. pp. 572–610, 1901.)—In describing the injuries to the skin which follow prolonged exposure to Röntgen rays, the author divides the changes into three periods: first, the period of erythema which appears about twenty-four hours after exposure and may last from ten to twenty-five days; second, the period of vesicles or blisters; these are accompanied by pigmention of the surrounding skin, and discharge a yellowish serum; this period lasts ten days or more, and there may be a loss of the hairs of the affected part during its continuance: third, the period of superficial ulceration; and fourth, the period of the formation of adherent necrosed sloughs. After this come the periods of deep ulceration and of slow cicatrisation. Characteristics of these cases are the intense irritation of the first stage, and the severe pains of the second and later stages. No known form of healing application seems to be of the slightest use for hastening recovery. The pains are relieved in part by applications which protect the surface from contact with air. A year or longer may elapse before healing. There is also a chronic form of Röntgen-ray burn which affects the hands of those who are much engaged about Röntgen-ray tubes. In this form the skin becomes gradually thickened, red and cracked, the hairs fall out, the nails become scaly and fall off. Unless precautions are taken, the hands become ulcerated and painful. The author affirms that the changes are due solely to the Röntgen-ray radiations, and not at all to the electrical discharges around the tube. The risk of accident is proportionate to the richness of the emission of Röntgen rays from the tube, to the nearness of the tube to the skin, and to the duration of the exposure or exposures. The "soft" tube of low resistance is far more likely to cause burns than a "hard" tube. Tissues which have been exposed to a course of Röntgen-ray treatment are rendered extremely vulnerable, and great care must be exercised in applying any treatment to them for a long time afterwards. L. J.

REFERENCE.

1070. *Photometric Apparatus.* **M. Herschkowitsch.** (Zeitschr. Instrumentenk. 21. pp. 364–366, Dec., 1901.)—The author's photometric apparatus is described, and minutely compared with that of H. Krüss, on the same principle. L. G.

HEAT.

1071. *Comparison of Platinum and Hydrogen Thermometers.* **B. Meilink.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 495–501, Feb. 22, 1902.)—This paper forms a part of a more general investigation, the problem treated here being that of an accurate expression of the resistance as a function of the temperature for a standard metal by comparing the platinum thermometer with the hydrogen thermometer. The arrangement of the resistance thermometer is given, temperature determinations being made to within 0·02° C. under favourable circumstances. The precautions necessary to bring the platinum wire and the hydrogen thermometer under the same conditions and to keep them for a long time at a constant temperature are indicated.

The heat due to the Joule effect and the influence of radiation and conduction of heat are diminished by bringing the wire into immediate contact with the liquefied gas. As naked wires were used, care had to be taken that the liquid bath should be a good insulator. The resistance consisted exclusively of glass and metal, so as to avoid the use of such substances as are liable to be attacked by liquefied gases. The Wheatstone bridge used is described, the means of eliminating the influence of contact resistances being pointed out. Finally, the operations necessary for determining the zero are carefully discussed. A. G.

1072. *Expansion of Mercury.* **L. Grunmach.** (Phys. Zeitschr. 3. pp. 134–136, Jan. 1, 1902. Paper read before the Versammlung deutsch. Naturforscher u. Aerzte, Sept. 25, 1901.)—An alcohol thermometer was made, and its readings between 0° and —80° compared with a standard. This was then filled, half with mercury and half with alcohol, and a fresh series of readings taken. The results are embodied in a series of curves. It is shown that between —38°·5 and —38°·7, when melting is taking place, the expansion is 86·50 times larger than for solid, and 58·68 greater than for liquid mercury. The expansion of solid mercury is 0·6784 that of the corresponding liquid. Melting increases the volume by about 5 per cent. R. S. W.

1073. *A Sensitive Thermostat.* **W. P. Bradley** and **A. W. Browne.** (Journ. Phys. Chem. 7. pp. 118–135, Feb., 1902.)—The heating is caused by the circulation of warm water produced by a rapidly revolving propeller, and the regulator consists of a glass spiral, 4 m. long and 5·5 mm. in bore (and therefore with 700 sq. cm. of surface), containing ethyl alcohol. The best results are obtained when the inflow is only "throttled" and not cut off. The water is itself heated in a thermally regulated reservoir, but its temperature in the reservoir may vary by ½° without affecting the regulation, which has a sensibility of 0·001°. R. E. B

1074. *A Form of Electric Thermometer.* **G. Meslin.** (Comptes Rendus, 134. pp. 412–414, Feb. 17, 1902.)—The paper describes a method of determining the temperature of a place where the ordinary thermometer cannot be directly observed. The variation with temperature of the e.m.f. of a Clark cell is made use of. The e.m.f. of the cell placed in the region whose temperature is to be observed is balanced against a known e.m.f. by a potentiometer arrangement. J. J. S.

1075. *Gas-thermometry.* **P. Chappuis.** (Phil. Mag. 3. pp. 243–247, Feb., 1902.)—I. A recalculation of the boiling-point of sulphur from Harker and Chappuis' former observations, when Holborn and Day's new measurements of the expansibility of Berlin porcelain are employed, gives 444·7° (instead of 445·2°), which is very close to Callendar and Griffiths' value. II. The coefficient $(\partial P/\partial t)/P_0$ for nitrogen, when P_0 is 1 m. of mercury, diminishes to a limiting value 0·00367380, which is reached near 75°, after which temperature the gas may be assumed to be perfect. Then, since $P_{100} = 1{\cdot}367466$, we have, for temperatures over 75°,

$$P = 1{\cdot}000086 + 0{\cdot}00367380t = 1{\cdot}000086(1 + 0{\cdot}00367348t),$$

or the corresponding ideal gas-thermometer would have $P'_0 = 1{\cdot}000086$ and $\alpha' = 0{\cdot}00367348$; and to reduce the readings τ of the unconverted nitrogen scale to this ideal scale we must add $0{\cdot}000234(\tau - 100)$. [See also Abstract No. 76 (1901)]. R. E. B.

1076. *Empirical Formula for Isothermals.* **J. E. Verschaffelt.** (Archives Néerlandaises, 6. pp. 650–656, 1901.)—The isothermals of carbon dioxide are found to be represented by formulæ of the form $p = p_1 + m(x - x_1) + a(x - x_1)^n$, where $x = 1/(v - b)$, b has the same value, 0·00045, as at the critical temperature, and the other constants are different for different temperatures. These constants are calculated for various temperatures above and below the critical temperature, and tables are given showing an agreement between the observed and calculated values of p, which the author considers within the limits of experimental error. W. E. T.

1077. *Ternary Systems, I.* **van der Waals.** (Konink. Akad. Wetensch. Amsterdam, Versl. 10. pp. 544–560, Feb. 22, 1902.)—This is the first part of a theoretical investigation of ternary systems. The equilibrium phenomena at a given temperature of a binary system have already been set forth by the author. Now in a ternary system, the method of expressing the free energy ψ in terms of volume and composition fails to afford a geometrical representation of those phenomena; the author therefore suggests making use of the property of the ζ-function to exhibit a minimum value for given values of T and p, according to Gibbs' phase-rule. In a ternary mixture, made up of $1 - x - y$, x and y molecules of the three components respectively, the value of ζ (see Arch. Néerl. Sér. II., tome 2, p. 71) will be given by the equation—

$$\zeta = MRT\left\{(1 - x - y)\log(1 - x - y) + x\log x + y\log y\right\} + \\ + \left\{pv - MRT\log(v - b_{xy}) - a_{xy}/v\right\} + Ax + By + C$$

It had previously (*l.c.*) been pointed out that such ζ surfaces will, as a rule, consist of three sheets, of which, however, only one represents states capable of being experimentally realised, the remaining ones being either metastable or unstable, although, in order to show the principle of continuity, they cannot be dispensed with.

From the differential equation, $d\zeta = v\,dp$, the author derives for a molecular quantity in the diluted gaseous state at a given temperature—

$$\zeta = f(T) + MRT\log p,$$

or—

$$\zeta = MRT + MRT\log(p/MRT),$$

the vapour branch of the ζ-curve thus climbing up, with increase of p, from

$-\infty$ for $p=0$, as represented by $a\,c\,b$ in Fig. 1, where e is the common point of the vapour and liquid branches. The further course of the liquid branch may easily be established by means of the equation $d\zeta = v dp$, while, by applying the principle of continuity, the continuation of the vapour branch, the unstable branch, and the beginning of the liquid branch $c\,e$ are to be found, b and c being inversion points. As long as the pressure lies between the two limits p_u and p_m (maximum and miniumum pressures of the isothermal), ζ will have a triple value. In the case of a homogeneous mixture, the ζ-curve is found to have the same form, the three values of ζ coinciding, as soon as T exceeds what is termed the critical temperature of the mixture. In order next to ascertain the connection between the different sheets of the ζ-surface of a ternary mixture at given values of T and p, the author first considers the three curves situated in the plane $y=0$, which is equivalent to seeking the connection between the three values of ζ for a binary mixture. Let (Fig. 2) the curve ABPB′A′ thus be the connodal line of a binary mixture in a x, v diagram, R being the critical point of contact, and P the folding-point. From A to P, as well as from A′ to P, the pressure of the coexisting phases of the binary mixture will increase. On the Figure, in addition to this connodal line and to the isopiëst crossing the points B and B′, there is plotted the curve CPC′, representing the limit of the stable and unstable homogeneous phases, this curve being defined by the equation $\partial^2\zeta/\partial x^2 p = 0$. Finally (CKC′) there is shown the curve $-\partial p/\partial v = \partial^2\psi/\partial v^2 = 0$, lying wholly within the former line. The point K may be considered as a vertical point of the mixture regarded as undecomposable. The course of the isopiëstic is next followed, with the result that for the chosen value of p there will exist a continuous series of phases of the binary mixture, the liquid and gaseous phases lying on the left side of B, and on the right side of B′ respectively. Metastable phases are to be found between B and E and between E′ and B′, whereas E and E′ will comprise the unstable phases. In the original paper a curve is given representing ζ as a function of x, at this pressure and this temperature, and it is shown how an existing complication in this curve may disappear. The author next investigates the case of a propagation of a similar complication, by considering the consequence of the pressure diminishing. He then proceeds to discuss the signification of the double point of the ζ-curve and of the displacement of the inflexion-point. The foregoing discussion affords a means of studying the geometrical configuration of the ζ-surface in the case

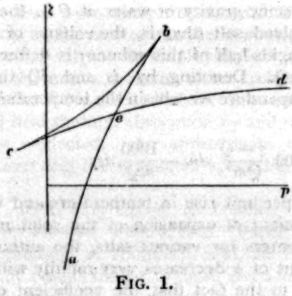


FIG. 1.

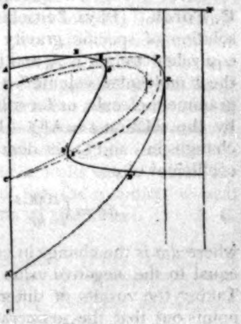


FIG. 2.

of a ternary system, and more especially at the critical circumstances of the gaseous and liquid states. The modifications shown in this case by the curves above mentioned are rapidly dealt with, the fold observed in the former case being substituted by a configuration termed "three-sheets fold."

From this geometrical discussion the following conclusions are drawn: the critical phenomena of a ternary system are equal to those of a binary system. At the chosen temperature all those mixtures will exhibit a special folding-point configuration indicated by the course of the point P, as stated in the original paper, the corresponding pressure being different for different mixtures. The limiting value of $(y_2 - y_1)/(x_2 - x_1)$ is given by the direction of the tangent in P to the connodal line. The mixtures corresponding, at the chosen temperature, to contact points are found by means of the envelope of the different binodal lines, those figured by points situated between the P-curve and the above envelope exhibiting retrograde condensation of the first species.

A. G.

1078. *Change in Molecular Volume of Dissolved Salts with Temperature.* **C. Forch.** (Phys. Zeitschr. 3. p. 183, Feb. 1, 1902.)—If a litre of an aqueous solution of specific gravity s at t° C. contain mA grammes of a salt whose equivalent weight is A, and if Q be the specific gravity of water at t° C., then the "molecular volume" ϕ of the dissolved salt (that is, the volume of a gramme-molecule, or for salts of dibasic acids half of this volume) is defined by the relation $\phi = A/Q - 1000(s - Q)/mQ$. Denoting by ds and dQ the changes in s and Q per degree rise in temperature we obtain the temperature coefficient of ϕ—

$$d\phi = \left(\frac{1000\,s}{m} - A\right)\frac{dQ}{Q^2} + 1000.\frac{s - Q}{Qm^2}\,.\,dm - \frac{1000}{mQ}\,.\,ds,$$

where dm is the change in concentration per unit rise in temperature and is equal to the negative value of the coefficient of expansion of the solution. Taking the results of different experimenters for various salts, the author points out that the temperature coefficient of ϕ decreases very rapidly with increase in temperature, corresponding to the fact that the coefficient of expansion of a salt solution at comparatively high temperatures is less than that of water. The temperature coefficient is practically independent of the magnitude of the molecular volume itself, almost independent of the dissolved substance when the number of gramme-molecules dissolved and the temperature interval are the same, and for values of ϕ ranging from + 210 to − 3 approximately the same for all bodies dissolved in water. A distinct dependence on the degree of dissociation cannot be traced. The "temperature coefficient of the molecular volume" seems therefore to be determined rather by the solvent than by the properties of the dissolved substance.

W. S.

1079. *Vapour-Pressures of Carbon Dioxide and of Ethane at Temperatures below* 0°. **J. P. Kuenen** and **W. G. Robson.** (Phil. Mag. 3. pp. 149–158, Jan., 1902.)—The low temperatures required in the measurement of these vapour pressures were obtained by means of sulphur dioxide and ammonia boiling under reduced pressure, the temperature being determined by a platinum thermometer. Vapour pressures are given for liquid carbon dioxide at temperatures varying from 0° to − 63·18° and for the solid from − 57·86° to − 78·32°. The triple-point diagram for carbon dioxide is given, this point being determined directly by changing the temperature until no gradual change in the amount of solid is observable, and indirectly by finding the point of intersection of the solid-vapour and liquid-vapour curves; the two values thus obtained are identical, the triple-point temperature being $-56{\cdot}2^\circ$ and the pressure 5·10 atmospheres. The liquid may be considerably undercooled as the lowest liquid-vapour point is 7° below the triple-point temperature. The numbers obtained for the vapour-pressures of ethane are not considered as accurate within 1 per cent. owing to the great difficulty of purifying the gas. T. H. P.

1080. *Determination of Freezing-points of Solutions.* **K. Prytz.** (Kongl. Danske Vidensk. Selsk. Kjöbenhavn, Forh. No. 1, pp. 17–30, 1902.)—The author has devised a method analogous to that used in the case of pure water, enabling freezing-points to be determined at temperatures maintained constant for any desired time. A double-walled Dewar vessel is filled up with finely pounded ice, and contains a thin helical brass tube surrounding a Beckmann thermometer, through which a constant supply of solution is allowed to enter the vessel and to overflow at its edge. The author shows that the temperature registered will tend asymptotically towards the freezing-point of the solution. The possible causes of error are enumerated, and necessary precautions discussed. This method allows of a direct determination of the zero of the thermometer, *i.e.*, of the freezing-point of the water used as solvent, by employing in a preliminary experiment pure water instead of solution. It seems to be preferable to the well-known suffusion method, as the latter gives reliable results only when the formation of ice and the loss of heat through absorption by and radiation from the walls of the vessel may be neglected. An approximate value is given for the quantity of heat traversing the evacuated space between the walls of the vessel. A. G.

1081. *Supercooling of Liquids.* **P. Bachmetjew.** (Phys. Zeitschr. 3. pp. 195–196, Feb. 1, 1902. Paper read before the 73rd Naturforscherversammlung at Hamburg, Sept. 25, 1901.)—This paper describes experiments and results similar to those given in Abstract No. 1653 (1901), but made with benzene and water, and also with insect juices. The different drops of suspended liquid solidified at different temperatures and the difference in behaviour is not due to differences in interior temperature or the like in the suspending liquid, but is probably to be explained by polymorphism in G. Tammann's sense of the word. D. H. J.

REFERENCES.

1082. *Thermostats and Thermoregulators.* **W. C. Geer.** (Journ. Phys. Chem. 7. pp. 85–105, Feb., 1902.)—A review of the thermostats dependent on the equilibrium of coexisting phases, and of the main types of automatic and non-automatic thermoregulators, which have hitherto been employed, is first given, and then a description of an efficient thermoregulator for controlling (to a sensibility of 0·002°) the temperature of an electrically heated thermostat. R. E. B.

1083. *Partition of Energy between Ether and Matter.* **M. Planck.** (Archives Néerlandaises, 6. pp. 55–66, 1901.)—In this paper the author sets forth the arguments and conclusions of former papers in a slightly modified form. [See Abstract No. 1284 (1901).] G. W. DE T.

ELECTRICITY AND MAGNETISM.

THEORY AND ELECTROSTATICS.

1084. *Electrodynamics of Bodies in Motion.* **E. Carvallo.** (Comptes Rendus, 134. pp. 165–168, Jan. 20, 1902.)—The writer claims to have discovered or rediscovered for bodies at rest the following laws : (1) The flux of the total electric current through any closed surface is zero. (2) The line integral of electromotive force round a closed curve is zero. In the present paper he discusses the electromotive force of induction due to movement of matter, as to which he says that in the case of conductors and electrolytes the force is the vector $(\dot{x}\ a)$, where $\dot{x}$ is the velocity of matter, and a the magnetic induction ; and for dielectrics he refers to M. Blondlot as having recently found the solution. In Section 4 he treats the electrodynamic equations for bodies in motion, namely, $\frac{du}{dx} = 0$, the equation of continuity, and—

$$\frac{dU}{dx} = a' - \frac{d}{dx}V(x'a)$$

a' being $\frac{da}{dt}$ and U the electromotive force. In conclusion he claims to have extended the two fundamental equations established for bodies at rest to bodies in motion, and to have given the electrodynamic equations for bodies in motion. The equation of energy, he says, is dealt with as in ordinary mechanics. S. H. B.

1085. *Magnetic Field due to Electric Convection.* **A. Righi.** (N. Cimento, 3. pp. 71–80, Jan., 1902.)—It is not yet possible to explain the entirely negative results of Crémieu, as compared with the positive results of others ; but one point arises in considering the reasonings of the latter. It is assumed that putting a metallic diaphragm between the moving charges and the needle screens off any direct electric action, but does not affect the magnetic force. If it did at the same time suppress the magnetic force, Crémieu's negative results would be explained ; but the positive results of others would remain unexplained. It was important, therefore, to know what was the electromagnetic field produced beyond an infinite conducting-plane by a charge moving uniformly in a straight line. This has been thoroughly worked out by Professor Levi-Civita in a paper to be published in the Annales de la Faculté des Sciences de Toulouse. The general result is that the conducting diaphragm, on being interposed, weakens the magnetic field beyond it, reducing it to zero if the diaphragm be infinitely conducting. The magnetic field would be reduced, say to 8 per cent., by a copper diaphragm, say to 49 per cent., by a tinfoil diaphragm. Nearly all experiments have, however, not corresponded to this case, but to a condition of stationary convection in which there is no such reducing effect ; with the exception of those of Adams, who did not employ a conducting disc divided into sectors, but a number of charged metallic spheres mounted on the circumference of a rotating wheel. In this case the magnetic force must be greatly reduced by the diaphragm. [See also Abstract No. 481 (1902).] A. D.

1086. *Motion of an Electrified Particle in the Electromagnetic Field.* **E. Riecke.** (Phys. Zeitschr. 3. pp. 182–183, Feb. 1, 1902.)—The problem considered is of interest in connection with certain of the author's experiments not yet published. He supposes an infinitely long cylindrical kathode of radius a, the electrostatic equipotential surfaces being cylinders coaxial with this kathode. The magnetic field is uniform, of intensity H, and its direction is parallel to the axis of the kathode. The author investigates the motion of a particle of mass m possessing a negative electrostatic charge of e units, the particle leaving the surface of the kathode with zero velocity. Then if V_a, V be the electrostatic potentials at the surface of the kathode and at distance r from its axis respectively, v the ratio of the electromagnetic to the electrostatic unit of quantity, it is shown that the path of the particle lies in a plane perpendicular to the axis of the kathode, and that the radial velocity vanishes at a distance r given by $r - a^2/r = (2v/\mathrm{H})\sqrt{2m(\mathrm{V}-\mathrm{V}_a)/e}$, the particle moving afterwards in a circle of radius r. The previous path is a spiral approaching this circle asymptotically. The greater the magnetic field intensity the smaller the radius of the circle. The result is in close relation to the contraction of the dark space in the magnetic field. W. S.

1087. *Effect of Nature of Surface on Contact Electricity.* **N. Hesehus.** (Jurn. Russk. Fisik. Chimicesk. Obscestva, No. 1*b*, pp. 1–15, 1902.)—By means of an extensive series of experiments on disks of various metals, the author shows how a polished surface will in all cases be positive with respect to a matt surface of the same substance. This is equally true of non-metallic bodies; among the experiments made in this direction, those performed with different kinds of wood are particularly interesting, the result arrived at being that a plate cut perpendicularly to the fibres will be negative with regard to a plate of the same material cut parallel to the fibres, the latter possessing a higher polish. As regards the case of two disks of different substances brought into contact, the author establishes the interesting proposition that a metal will prove the more positive, as its hardness is less, while on the other hand a non-metallic body exhibits a negative potential difference with respect to a softer material. For both classes of substances very full series are given. Some apparent exceptions to this rule are easily explained by taking into account either the hygroscopic properties of those bodies, it being shown that a wet plate will be positive with regard to a dry one of the same material, or the law that of two different superficial modifications of a body the one possessing a higher superficial density will be positive with regard to the other. Thus, viscid substances, or substances capable of giving off dust, will always be positive, whatever body they are brought into contact with; dust will in all cases exhibit a negative p.d. with respect to the body it is taken from, because its superficial density is less. Many atmospheric phenomena may be interpreted by taking account of the electrification of dust. Finally the well-known fact that two pieces of quartz or other substances when struck together will shine in the dark, is investigated, the result being that both pieces will carry a positive charge, an almost invisible layer of dust negatively charged being interposed between them. [See also Abstract No. 319 (1902).] A. G.

1088. *Crystallisation under Electrostatic Stress.* **P. R. Heyl.** (Phys. Rev. 14. pp. 83–88, Feb., 1902.)—It was thought possible that electrostatic stress might act on crystals formed under its influence so as to alter the interfacial angles and probably also the density. HgI_2, a salt sensitive to slight mechanical disturbances, was employed as indicator, but no effect was found. Hence, negatively, electrostatic stress does not affect crystallisation, or, positively any molecular forces called into play in a solution under electrostatic stress are not comparable with the forces of crystalline attraction. R. S. W.

DISCHARGE AND OSCILLATIONS.

1089. *Constitution of the Electric Spark.* **G. A. Hemsalech.** (Journ. de Physique, 1. pp. 76–90, Feb., 1902.)—An analysis of the investigations of Schuster and Hemsalech, and of the latter alone, on the electric spark. [See Abstracts Nos. 1066 (1900) and 1510 (1901). Much of the contents of the present paper is already dealt with in the latter of these two Abstracts.] An electric spark is produced in the following manner: The layer of air between the two electrodes is first pierced by the initial discharge; then the air in the immediate neighbourhood of the path traversed by the discharge becomes incandescent: this is the "luminous path." But immediately afterwards the space between the electrodes becomes filled with metallic vapour produced by the initial discharge: this is the "aureole." The oscillations following the initial discharge traverse this vapour and reheat it. If self-induction be put in the circuit, with increase of self-induction the form of the "aureole" becomes more and more regular, while the initial discharge becomes more and more feeble. Without self-induction, the discharge is abrupt and almost all the energy is in the initial discharge; with self-induction, the induced currents prevent a rapid discharge. Almost all the energy is spent in heating the metallic vapour; it is only the feeble initial discharge which traverses the air, and its strength is not great enough to heat the air to incandescence although sufficiently strong to produce metallic vapour. With an iron or copper tube inserted as core of the induction coil, the oscillations of the discharge are destroyed and we have a single discharge. This is due to magnetism of the iron and to Foucault currents; in the case of iron, both causes are at work, and their effects are added, while in the case of copper, only the Foucault currents are operative. W. C. H.

1090. *Action of Incandescent Metals in Producing Electric Conductivity in Gases.* **J. A. McClelland.** (Cambridge Phil. Soc., Proc. 11. pp. 296–305, Feb., 1902.)—The paper contains an account of some experiments on the nature of the conductivity produced in gases by the action of incandescent metals. Results are given and curves plotted for the case of an incandescent wire in air at atmospheric pressure and at reduced pressure. At atmospheric pressure, positive carriers appear in the gas near the wire before negative carriers, but when the temperature is sufficiently high, carriers of both signs are given off, and are approximately equal in amount at very high temperatures. At reduced pressure, when the wire is heated by a current and at the same time is raised to any required negative potential above that of a cylinder surrounding it, the current between wire and cylinder at first rises proportionately with the potential difference, then shows signs of reaching a maximum, and afterwards increases rapidly. This second increase is explained by secondary ionisation caused by collisions between negative carriers and molecules. With the wire charged positively, a similar effect is observed, indicating that the positive ions travelling out from the wire have produced secondary ionisation. As the e.m.f. for which this secondary ionisation begins, is not very different in the two cases, it appears that the masses in the two cases are not very different. The experiments on ionisation in air by Röntgen rays or ultra-violet light, on the other hand, all show that the negative ion is very small compared with the molecule, while the positive is of molecular magnitude. These results obtained by the author are for a pressure of $\frac{2}{3}$ mm. At a pressure of $\frac{1}{10}$ mm. a smaller voltage is sufficient to produce ionisation by collisions of the negative ion than that required to give the necessary velocity to the positive, but the experiments show that the positive ion can be given the velocity necessary to produce ionisation. In these experiments with a hot wire there are many indications that we are dealing not only with ions produced from the molecules of the gas, but also with ions actually given off from the hot wire itself. Thus at a pressure of 1 mm. or less, the current, when the wire is negative, may be 50 times what it is when the wire is positive, and such a difference from what is observed at atmospheric pressure suggests that, at low pressure, we get a copious supply of negative ions from the wire itself. Again, as the current with wire negative was practically constant when the pressure was varied from $\frac{1}{25}$ mm. to $\frac{1}{340}$ mm., it may be suggested that, at such pressures, the ions from gas molecules are small in number compared with those coming from the wire. Possibly the positive ions producing secondary ionisation also come from the wire, and this may account for the apparent difference between them and the positive ions investigated in other cases of ionisation. Further experiments on the subject are promised. [See also Abstract No. 1854 (1900).]

W. C. H.

1091. *Negative Radiation from Hot Platinum.* **O. W. Richardson.** (Cambridge Phil. Soc., Proc. 11. pp. 286–295, Feb., 1902.)—McClelland has shown that the electric radiation from hot platinum is invariably negative, whatever the surrounding gas. This suggests the idea that in the negative radiation at high temperatures the phenomenon of conductivity produced by metals takes its simplest form. Considering, then, the negative ions as moving freely in the metal, like air molecules in the atmosphere, subject to the speed-law $dn = n\,(km/\pi)^{\frac{3}{2}}\,\text{exp.}\left\{-km\,(u^2+v^2+w^2)\right\}du\,dv\,dw$, where n is the number of ions in unit volume, $3/4k$ the energy of an ion and m its mass, and Φ the work done by an ion in escaping through the surface-layer of the metal where we must suppose a discontinuity in the potential which hinders the escape of the ions, the number of ions which escape per unit area per second is—

$$\mathrm{N} = \int_{\sqrt{(2\Phi/m)}}^{\infty} \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} u\,dn = \tfrac{1}{2}\,n\,(km\pi)^{-\frac{1}{2}}e^{-2k\Phi} = n\,\sqrt{}\,(\mathrm{R}\theta/2m\pi)\,e^{-\Phi/\mathrm{R}\theta}$$

since $k = (2\,\mathrm{R}\,\theta)^{-1}$, where R is the gas-constant for a single ion. The saturation current s of the negative radiation should therefore on this theory obey the law $s \propto \theta^{\frac{1}{2}}\,e^{-b/\theta}$, where b is a constant. Experiments were therefore made to determine the saturation currents from a hot platinum wire at various temperatures θ (abs.), when placed concentrically with an aluminium cylinder in a bulb which was exhausted to pressures between 0·01 and 0·16 mm. of mercury, and these were found to fully confirm the theoretical law. They further allowed the following estimates to be made, viz., that the number of free negative ions in a cubic centimetre of platinum at 1,269° C. is $1{\cdot}3 \times 10^{21}$, and that there is a discontinuity in the potential at a platinum-vacuum surface amounting to 4·1 volts.

R. E. B.

1092. *Coronas of Cloudy Condensation, and Contrast of Axial and Coronal Colours.* **C. Barus.** (Amer. Journ. Sci. 13. pp. 81-94, Feb., 1902.)—The author describes his further researches on the coloured coronas formed in moist nucleated air in contact with a steam jet. The tubular apparatus used in early experiments was discarded, a spherical receiver being found preferable for studying coronal effects. " With divergent sunlight the display is gorgeous, the colours glowing metallically." The changes which the coronal colours undergo, as the number of nuclei is decreased by a process of successive exhaustion, are tabulated. The effects due to loss of nuclei with lapse of time, when the receiver is left for long intervals without exhaustion, are also discussed. For studying the axial colours, *i.e.*, the colours of the steam jet, a double conical dram (apices outwards) was used. Calculations are given relating to the size of the water particles, and of the nuclei. [See also Abstracts Nos. 691 and 871 (1902).] A. E.

1093. *Radio-activity in Atmospheric Air.* **H. Geitel.** (Archives des Sciences, 13. pp. 113–128, Feb., 1902.)—A summary is given of the previously published researches of the author and J. Elster on the dissipation of electric charges from bodies placed in air, on the conductivity produced in air by radio-active substances, and on various phenomena of radio-activity. The experiments carried out lead the authors to the conclusion that any conductors placed in a large mass of air, on being charged negatively, become covered with a superficial layer possessing temporary radio-activity. Experiments conducted in natural caves and in a large disused cellar where the air had been in repose for months and where there was complete absence of radio-active substances, showed a remarkable conductivity possessed by the air in these circumstances. It is suggested that the existence in the air, and gases in general, of ions capable of forming combinations with the negative electrons at the surface of conductors may be the primary phenomenon from which that of radio-activity should be deduced. The question then arises if it is possible also to combine the negative ions of the air with the positive electrons of electrified conductors. Up to the present time it has not been found possible to obtain on conductors charged positively superficial layers presenting properties analogous to those which are met with in the case of negative conductors. [See also Abstract No. 1918 (1901).] J. J. S.

1094. *Magnetic Tubes of Force made Visible by Kathode Rays.* **H. Pellat.** (Comptes Rendus, 134. pp. 352–355, Feb. 10, 1902.)—The author finds that when the kathode has the form of a disc in an intense magnetic field the rays emanating from the kathode delineate exactly the tube of magnetic force having the surface of the kathode for base, the rays leaving the whole surface of the disc uniformly. The phenomenon is quite distinct from that presented by the anode rays, which have also a tendency to follow the lines of force of the field, but issue from the edge of the anode, and do not represent a magnetic tube of force. The kathode rays obeying the above law, the author calls the flux A, to distinguish them from another set of kathode rays (flux B), different in colour and in other properties. [See also Abstract No. 815 (1899).] The flux A experiences no electromagnetic action tending to deflect it at right angles to the lines of force, be the field intense or weak. It always leaves the kathode in the direction of the field, whether that direction be normal, oblique, or tangential to the surface. In zero field and weak fields (up to 300 c.g.s.) the flux A leaves the kathode in all directions, and on both sides, forming a sort of atmosphere round it. The figure formed by the flux A is independent of the sense of the field; it is otherwise for the anodic flux and the flux B. The distinctness of the lateral part of the tube is independent of the pressure of the gas so far as the author's experiments go (4 mm. to 0·004 mm). At 3,000 c.g.s. no want of continuity could be detected by a lens. At 300 c.g.s. nothing could be clearly distinguished. The author goes on to describe in detail the appearances at different pressures. The spectrum of the violet light due to the flux A was examined at a pressure of about 0·5 mm.; only radiations due to air were observed, none of the radiations characteristic of aluminium or its impurities. W. S.

1095. *Transparency of Conducting Liquids for Hertzian Waves.* **C. Nordmann.** (Comptes Rendus, 134. pp. 417–420, Feb. 17, 1902.)—The author has confirmed and extended his experiments on the absorption of Hertzian waves by electrolytes. [See Abstract No. 2376 (1901).] He finds that the maximum thicknesses after traversing which the Hertzian waves employed are still sensible, that is the transparencies for these waves, vary in the same sense as the resistances; they increase less quickly than these latter and more quickly than their square roots. J. J. S.

1096. *Application of Thermal Galvanometers to the Study of Electric Waves.* **L. de Broglie.** (Comptes Rendus, 134. pp. 349–352, Feb. 10, 1902.)—The author has studied the circumstances under which thermal ammeters can be employed in the study of wireless telegraphy. The transmitter was that of the wireless telegraph station at Saint Louis, having an antenna 24 m. in vertical height, and joined to earth through an induction coil. Between the base of the vertical transmitter and the induction coil could be inserted a known number of brass wire coils 30 cm. in diameter. The receiver, about 30 m. distant, was also vertical, and joined by its lower extremity to one terminal of a milliammeter, the other terminal of which was joined to earth by a short wire. Between the base of the receiver and the milliammeter could be inserted any required number of closely-packed wire coils on a wooden base 5 cm. in diameter. When a disturbance was propagated from the transmitter a deflection was obtained on the milliammeter, which attained a very distinct maximum for a certain number of coils added between the receiver and the instrument. If a certain number of coils were added to the emitter, a *proportional* number had to be added to the receiver to secure the maximum deflection. The author also investigates the effect of modifying the emitted wave in various ways, *e.g.*, by varying the spark-length or the number of brass wire coils added, or by replacing the single vertical wire 24 m. long by other antennae of equal length, such as an antenna consisting of four branches. When the transmitter was replaced by a wire 40 m. long two maxima separated by a minimum were found in place of the former maximum, the absolute value of the largest of those two maximum deflections being decidedly less than the former maximum. The author investigates also the effect of varying the type of receiver, *e.g.*, by using a single wire or a number of wires in parallel, and of winding a secondary coil round that added between the receiver and the amperemeter. W. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1097. *Elimination of Corrections for Leads in Cable Testing.* **H. Savage.** (Elect. Rev. 50. pp. 86–88, Jan. 17, and pp. 124–125, Jan. 24, 1902.)—In capacity tests the deflection on the lead is taken with the galvanometer unshunted, and when deducted from reading of cable it is divided by the multiplying power of the shunt used on the latter. Thus if the deflection on the lead = *d*, deflection of cable with galvanometer shunted $= D$, true deflection on cable $= D_t$, and multiplying power of the shunt $= n$, then $D_t = D - d/n$. This is true for a simple shunt arrangement, but if the leads from the keys, &c., to the galvanometer have any appreciable capacity, it is not strictly so for "universal" shunts. In using the latter care must be taken to see that the connections are made as in Fig. 1. The current must enter at one terminal of the fixed resistance R. If $d_{gl} =$ deflection due to galvanometer leads, and $d_{tl} =$ that due to the testing lead, then $D_t = D - (d_{gl} + d_{tl}/n)$. But if the connections are reversed, d_{gl} will vary. The correction for the testing lead makes the results of insulation, electrification, and loss of charge readings uncertain. To eliminate this, the author adopts an extension of Price's guard-wire system for cable ends. He applies a surrounding or concentric conductor to the whole lead, insulated from the inner. The outer is joined direct to the battery. The inner and outer being practically at the same potential, there will be no deflection due to leakage between them, and that between outer and earth does not affect the galvanometer. In capacity tests it is necessary to charge the two conductors together and to insulate them simultaneously, but to discharge the outer direct to earth immediately before discharging the inner through the galvanometer. The author considers that the concentric lead affords complete shielding from induction effects of neighbouring leads, and the outer being of fine copper wires is more flexible and more convenient than one with a lead covering or metal taping as commonly used. The concentric lead is also useful for joint testing, by using it as a condenser to collect the leakage from the joint. The required connections are shown in Fig. 2. The outer is earthed, the inner joined to a plate in the trough. The latter is charged with a few cells, and discharged deflections noted; again charged, insulated for a minute, and again discharged. If the loss is small, the insulation of the trough is good. The cable is charged, say, with 300 cells. This will give a deflection due to capacity of the joints. Leaving the battery on the cable, the inner is now insulated for a minute, the leakage from the joints then accumulating in the lead. After a minute this is discharged and the deflection compared with a standard length of good core. In this test the ends of the inner must be well insulated. A diagram of a system of keys arranged to meet all these conditions is given. E. O. W.

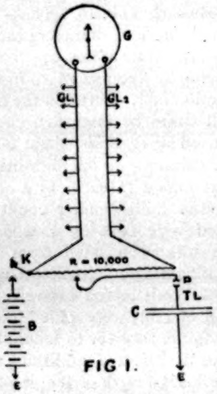


FIG I.

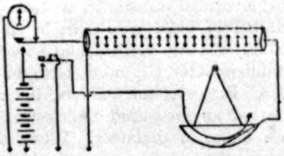


FIG.2.

1098. *Use of Duddell's Musical Arc for Measuring Small Self-inductances.* **P. Janet.** (Comptes Rendus, 134. pp. 462–463, Feb. 24, 1902.)—When a condenser of capacity C in series with a self-induction L is put as a shunt on a continuous-current arc, under certain conditions of regulation, an alternate current of periodic time $T=2\pi\sqrt{CL}$ flows in the condenser circuit. Measure this current by means of a hot-wire ammeter, also measure the potential difference e at the terminals of the self-induction with a hot-wire voltmeter. Then, neglecting the resistance of the self-inductance as compared with its reactance, the current $I=e/L\omega$, $\omega=2\pi/T$. Hence $L=e^2C/I^2$, thus allowing L to be calculated from purely electrical measurements.
E. C. R.

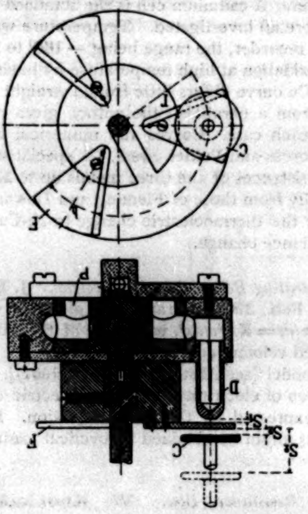
1099. *Thermo-electric Force of Nickel, Copper, and Iron.* **E. P. Harrison.** (Phil. Mag. 3. pp. 177–195, Feb., 1902.)—Two accumulators send current through 1,000 ohms and then a potentiometer wire, the thermo-couple balancing on the latter. A cadmium cell is the standard e.m.f. The Cu-Fe, Fe-Ni, and Ni-Cu were all investigated. Temperature was registered by the Callendar automatic recorder, the range being —180° to 1,050°. Special care was taken to avoid oxidation at high temperature by having an atmosphere of hydrogen. The Ni-Cu curve differs little from a straight line, and the Cu-Fe curve differs little from a parabola; the author gives equations to express these differences in each case. Curves and numerical tables are given for the thermoelectric forces and Peltier effect. A special set of measurements were made on the resistances of the three metals up to 1,000°. The author's results differ materially from those of Fleming and Dewar in most cases. One result is to show that the thermoelectric change in Ni-Cu coincides approximately with the resistance change.
P. E. S.

1100. *Model Illustrating Behaviour of Dielectrics.* **J. Buchanan.** (Phil. Mag. 3. pp. 240–243, Feb., 1902.)—Graphs are given of certain solutions of Fourier's equation, $dv/dt=K.d^2v/dx^2$, which are of the same form as the displacement and derived velocity curves given by Fleming and Ashton in the description of their model [see Abstract No. 2141 (1901)]. The motion of the model and the diffusion of electricity into the dielectric of a condenser are subject to the law expressed by the above equation. It is suggested that "hysteresis" diagrams might be obtained by cyclical loading of the springs.
W. E. T.

1101. *New Plug Resistance Box.* **W. Knobloch.** (Elektrotechn. Zeitschr. 23. pp. 132–133, Feb. 13, 1902.)—The author points out that in the ordinary arrangement of plug resistance boxes fifteen plugs must be inserted and two withdrawn to change from 999·9 ohms to 1,000·1 ohms, and he describes an arrangement of plug contacts with which such changes of resistance can be effected by comparatively few changes of the plugs.
G. H. B.

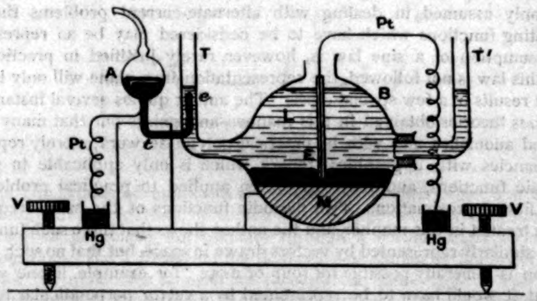
1102. *Wehnell Interrupter.* **A. H. Taylor.** (Phys. Rev. 14. pp. 118–121, Feb., 1902.)—The author uses carbon as the anode, in place of platinum. For a 6-in. spark coil worked directly off 100-volt supply without extra resistance in series, the best form of interrupter was one in which a carbon rod 3 mm. diameter was employed. This rod is copper-plated to within a few millimetres of the active end, and fits loosely in a glass thistle-tube, which dips into the electrolyte. The lower end of the thistle-tube is slightly drawn out on one side, and bent inwards so as to form a stop for the carbon rod. As the rod wears away, it slides down. The object of the copper-plating is to increase the conductivity and to prevent excessive heat in the rod. The thistle-funnel fits tightly through a cork, and the cork fits the vessel containing the electrolyte. Liquid is consequently forced up the stem of the funnel, owing to the pressure of the gasses generated, until equilibrium is attained. The author uses as the electrolyte one part of potassic hydrate to four of water. For X-ray work, direct-current is recommended, but for wireless telegraphy an alternate current is preferred, because it works more evenly. R. A.

1103. *Reiniger, Gebbert, and Schall's Mercury Interrupter for Induction Coils.* (Elektrotechn. Zeitschr. 23. pp. 107–108, Feb. 6, 1902.)—In this arrangement, the mercury is pumped up through a nozzle D against the underside of a vertically adjustable contact disc C by means of a small centrifugal pump arranged in a casing P. The apparatus is mounted in a glass vessel which is filled up to the lower edge of the nozzle D with mercury, and nearly up to the top with a spark-quenching liquid, such as alcohol or petroleum. In order to break the circuit, a series of vanes F of insulating material are mounted on the same spindle as the pump and successively cut the mercury jet. With 6 vanes, 9,000 interruptions per minute can be obtained with a 200-volt current. Formulæ are given for the length of each contact under various conditions. C. K. F.



1104. *Simple Liquid Resistance for Laboratory Use.* **R. Abegg.** (Zeitschr. Elektrochem. 8. pp. 43–44, Jan. 16, 1902.)—A short description and figure of the apparatus are given. It consists essentially of a V-tube, containing the liquid which is to be used as a resistance. One electrode is contained in the upper part of each arm of the tube, the resistance between them being varied by raising or lowering a glass rod in the liquid. The use of a thin rod gives a delicate adjustment over a short range; with a stouter rod the adjustment is not so fine, but the range greater. If both thin and thick rods are employed, a very fine adjustment may be obtained, over a wide range, and the apparatus is suitable for use with liquids of very different conductivities. W. C. H.

1105. *A Capillary Electrometer.* **P. Boley.** (Comptes Rendus, 134. pp. 463–465, Feb. 24, 1902.)—Lippman's capillary electrometer cannot be worked with saturated liquid amalgams, as these are not sufficiently mobile in small capillary tubes. In order to undertake the study of the contact e.m.f's. of these amalgams, the author was led to the construction of the form of capillary electrometer shown in the accompanying illustration. The mercury (or amalgam) is contained in a pipette A, whose lower tube *t* is drawn out and bent twice at right-angles. *t* has at its vertical extremity *e* an interior diameter of about 1 mm., it is at this spot that the meniscus forms, so that the electrometer might be called "a free-drop electrometer." The emerging drop is surrounded by the electrolyte L contained in the glass bulb B and the tubes T and T′, the latter of which, being capable of turning, serve to empty the apparatus. The other electrode E has a diameter of about 12 cm., and its large surface thus renders it practically unpolarisable. Some of the first results obtained with this form of electrometer are given in the paper.



E. C. R.

1106. *Single-Contact Coherers.* **E. Branly.** (Comptes Rendus, 134. pp. 347–349, Feb. 10, 1902.)—The author describes experiments with single-contact radio-conductors, which he has found to be sensitive as well as regular in action. He has obtained good results from oxidised metal in contact with oxidised metal and from polished metal in contact with polished metal, but gives preference to oxidised metal in contact with polished metal. In one piece of apparatus three small parallel rods of the same metal are soldered at one set of extremities to a metal disc; the other ends are oxidised and rest *freely* on a plate of polished steel, giving three contacts in parallel. Conductivity was established by a very feeble spark at more than 30 m. distance, while tubes of filings were not always affected at that distance. The author obtains constant results when the small parallel rods are of iron, cast steel, rolled steel, tempered steel, aluminium, silver, copper, nickel, zinc. W. S.

ALTERNATING CURRENTS AND MAGNETISM.

1107. *The Treatment of Alternating-Current Problems by Means of Vector Diagrams.* **J. Teichmüller.** (Elektrotechn. Zeitschr. 23. pp. 1–5, Jan. 2, and pp. 30–33, Jan. 9, 1902.)—The author considers the application of vector diagrams to various alternating-current problems, with special reference to the various methods of arranging a polyphase system of conductors, and the maximum drop which can occur in unequally loaded polyphase systems.

A. H.

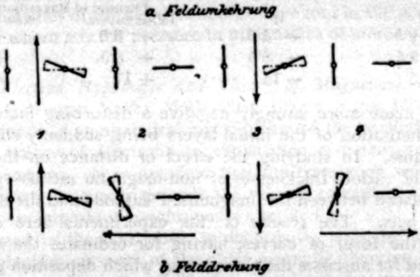
1108. *Limitations of Graphics in Electrical Theory.* **A. Russell.** (Inst. Elect. Engin., Journ. 31. pp. 438–441, Feb., 1902.)—Any number of simple harmonic functions, to which the p.d's and currents in an alternating-current network sometimes approximate, may have their effective values and phase differences represented by vectors in a common plane, and it is very commonly assumed in dealing with alternate-current problems that the fluctuating functions which have to be considered may be so represented. The assumption of a sine law is, however, rarely justified in practice, and when this law is not followed, the representation in a plane will only lead to correct results in a few special cases. The author quotes several instances of erroneous theories obtained in this manner, and points out that many of the so-called anomalies met with in practical polyphase work, merely represent discrepancies with a graphical theory which is only applicable to simple harmonic functions, and therefore, when applied to practical problems, is only a first approximation. Two periodic functions of the same frequency may be treated in this manner, and the author shows that three such functions may be similarly represented by vectors drawn in space, but that no such representation is generally possible for four or more; for example, if one were a constant, it would have to be represented by a vector perpendicular to each of the three others, which is impossible if these form a solid angle.

G. W. de T.

1109. *Permeameter for Testing Materials in Bulk.* **C. V. Drysdale.** (Inst. Elect. Engin., Journ. 31. pp. 283–306; Discussion, pp. 306–320, Feb., 1902.)—An instrument capable of testing the magnetic qualities of large or small castings or forgings without the preparation of test pieces has been designed. A drill of special form is employed, which cuts a circular hole with a conical top in the specimen, but leaving a pin in the centre. The hole is usually $\frac{3}{8}$ in. diameter and $\frac{5}{8}$ in. deep, and the diameter of the pin is $\frac{1}{10}$ of an inch. The testing arrangement consists simply of a soft iron plug carrying a bobbin, on which are wound two circuits, a magnetising and a search coil. The plug is split, and turned slightly conical on its outside surface, while the drill cuts the cone of the same angle as that of the plug. Hence, on drilling the hole and inserting the plug, a miniature permeameter is produced. In the event of it not being allowable to bore a hole of such a size, it is proposed to leave a boss on the casting in any convenient place, and which could be subsequently cut off. The readings may be taken by three methods, which are described, but the author prefers the simple ballistic test, and he has arranged two commercial forms of apparatus suitable. One type allows the permeability and retentivity to be directly read off, the other enables the magnetisation curve and the B-H cycle to be plotted. The accuracy ordinarily obtained is sufficient for all engineering purposes. In the discussion, the general opinion was that the instrument was a very practical one, and would prove of great service to dynamo manufacturers.

W. W. H. G.

1110. *Hysteresis in a Rotating Field.* **R. Hiecke.** (Elektrotechn. Zeitschr. 23. pp. 142–143, Feb. 13, 1902.)—Referring to Dina's paper [see Abstracts Nos. 2050 (1900) and 85 (1902)], the author points out that the conditions of Dina's experiments corresponded more nearly to an alternating than to a rotating field, and hence some of his results are untrustworthy. Thus, Dina finds the hysteresis in a rotating field to be for low inductions only slightly greater than that in an alternating one, whereas the author and A. Grau found that the rotating hysteresis is almost exactly double the alternating one. This latter result is easily accounted for by the molecular theory. For if we consider two groups of molecules at right-angles to each other, and apply a weak alternating field, then, as shown by the upper row of diagrams, only one group of molecules will oscillate through a certain angle about their mean position. But a weak rotating field will—as shown by the lower row—cause *all* the molecules to oscillate through the same angle. The author further shows that, according to the molecular theory, the maximum value of rotating hysteresis should occur at a value of the intensity of magnetisation $= \frac{2}{\pi}$ times the maximum magnetisation. This result is fully confirmed by experiment. A. H.



1111. *Electromagnets.* **F. R. Dietze.** (Elektrotechn. Zeitschr. 23. pp. 131–132, Feb. 13, 1902. Paper read before the Ninth Annual Meeting of the Verband Deutscher Elektrotechniker in Dresden.)—The article describes various types of electromagnets for lifting or other purposes. The author distinguishes between "core-magnets" and "mantle-magnets." In the former the armature moves outside the coils, or is drawn into them; in the latter the armature lies within the coil, which is surrounded by iron. The mantel type of magnet has the advantages of a very small stray field, a well-protected coil, and facility in adapting an air dash-pot.

A ring-magnet is described, with diametral armature to give a turning movement. Figures are given of the pull obtainable from different types of magnets, but the data are incomplete. G. H. B.

1112. *Contact Magnetising Action.* **C. Maurain.** (Journ. de Physique, 1. pp. 90–100, Feb., 1902.)—The author describes experiments made with a view to the further elucidation of the magnetising action of iron deposited in a magnetic field. In the first series of experiments a brass rod is coated with iron by electrolytic deposition in a certain magnetic field, the deposit assuming a definite magnetisation; then the field is suddenly changed, either to zero or to some other value. When the field is simply suppressed the layers of iron deposited afterwards have an intensity of magnetisation almost as great as that of the initial layers; thus with initial fields of 15 and 1·8 gausses, the magnetisation of the new layers is 0·85 and 0·87, respectively, of that of the initial layers. When the sign of the field is changed the action of the initial layers on the new ones is much stronger than that of the new field, as may be seen from the following numbers, H and H′ representing the strengths of the initial and final fields respectively:—

		Intensity of Magnetisation.	
H.	H′.	Initial Layers.	New Layers.
+ 9·5	− 1·5	+ 3·6	+ 3
+ 9·5	− 8·5	+ 3·5	+ 2·6
+ 15	− 15	+ 17	+ 7

If the field is made more strongly negative a disturbing factor comes into play, the magnetisation of the initial layers being suddenly changed from a + to a − value. In studying the effect of distance on the magnetising action, layers of various thicknesses of non-magnetic metals—gold, silver, or copper—are placed between the magnetised kathode and the deposit of iron on which it acts. The results of the experiments here described are expressed in the form of curves, having for ordinates the magnetometer deflections, and for abscissæ the time during which deposition goes on in the negative field, the initial deposit being positively magnetised. For the sake of comparison the corresponding curve for the case when no non-magnetic metal is interposed is also given. The general character of the results obtained may be understood from the curves obtained with gold as the intermediate metal. When no gold is used the curve is of course a straight line, having a certain slope representing the intensity of magnetisation; with a deposit of gold 19.8×10^{-6} mm. in thickness the slope of the curve is lessened considerably, and this is more and more the case as the thickness increases, the curves bending over and passing through the axis of abscissæ; with the thicker layers of gold, such as 136×10^{-6} mm., the magnetometer shows a negative deflection immediately the second deposit of iron is commenced. For copper and gold the corresponding thicknesses required to give equal effects on the magnetisation are about the same, but for silver greater thicknesses appear to be necessary, but great difficulty was met with in obtaining regular deposits of this metal. [See also Abstracts Nos. 2235 (1900) and 392 (1901).] T. H. P.

1113. *Motion of Electrolytes in a Magnetic Field.* **P. Drude.** (Zeitschr. Elektrochem. 8. pp. 65-67, Jan. 30, 1902.)—The experiment described by O. Urbasch [see Abstract No. 107 (1901)] could in no case succeed unless there were an electric current in the electrolytes, as by both of them being in contact with the same metal, and in Urbasch's experiment this was the case. A. D.

1114. *Hall Effect in Gases at Low Pressures.* **H. A. Wilson.** (Cambridge Phil. Soc., Proc. 11. pp. 249-263, Feb., 1902.)—A very large Hall effect is found in the positive column of the ordinary electric discharge in gases at low pressures, the electrodes being immersed in an apparently uniform positive column produced by a sensibly steady current. The application of the magnetic field always produces a transverse motion of the positive column, so that it becomes brighter along one side of the tube than along the other, the shift being in the direction in which a flexible conductor carrying a current moves. The Hall effect is proportional to the magnetic field, is probably nearly independent of the current at pressures down to 0·26 mm., and varies inversely as the pressure. If the influence of the walls of the discharge tube be neglected, Larmor's theory for completely dissociated salt solutions (Æther and Matter, p. 301) applies without modification to the uniform positive column. The walls of the tube and the electrodes do no doubt absorb charges, but these are, especially when the currents used are very small, too small to influence the measurements made. The actual difference between the velocities of the negative and positive ions in the positive column is $4·95 \times 10^{8}/p$, where p is the pressure in millimetres of mercury. A. D.

1115. *The Electron Hypothesis and Theory of Magnetism.* **W. Voigt.** (Gesell. Wiss. Göttingen, Nachr. Math.-Phys. Klasse, 3. pp. 169–200, 1901.)—This paper consists of an analytical investigation of the possibility of obtaining from the theory of electrons an explanation of paramagnetic and diamagnetic phenomena. It is assumed that the translation velocities of the electrons are small in comparison with the velocity of radiation; and, on this assumption, some important conclusions are arrived at.

It is assumed in the first place, in accordance with the analogy of the unresisted molecular currents of the older magnetic theories, that the electronic motions are undamped, and it is then found that changes in the velocities of the electrons in consequence of the formation of magnetic fields will not give rise to magnetic phenomena. The effects of damping, which play so important a part in the optical phenomena of dispersion, are then considered, and the author shows that if the electronic motions of a body in a constant magnetic field are subject to damping, while at the same time the energy dissipated is supplied by means of any completely irregular series of impacts, as, for example, with other electrons, or with ponderable molecules, so that the mean value of the energy tends to a fixed limit, the body will exhibit paramagnetic or diamagnetic properties, according to whether the mean energy of the electrons after the impacts is mainly potential or mainly kinetic. Finally it is shown that the presence in a magnetic field of rotating bodies carrying electric charges can only give rise to diamagnetic phenomena when they experience no resistance. Charged bodies, on the other hand, rotating against resistance and having their energy loss made up by means of irregular impacts, may give rise to either paramagnetic or diamagnetic phenomena. G. W. DE T.

ELECTROPHYSIOLOGY AND ELECTROTHERAPEUTICS.

1116. *The Effect of Electric Waves on the Human Brain.* **A. F. Collins.** (Elect. World and Engineer, 39. pp. 335–338, Feb. 22, 1902.)—The author traces a connection between atmospheric electrical disturbances and their effect upon human beings by supposing a coherer-action of the brain tissues. He describes experiments with fresh brain substance which seem to show that variations in resistance, like those of a coherer, can be obtained with conductors embedded in fresh brain tissue. L. J.

1117. *High-Frequency Currents for Producing Analgesia in Dentistry.* **L. R. Régnier** and **H. Didsbury.** (Comptes Rendus, 134. pp. 373–375, Feb. 10, 1902.)—The authors advise the employment of currents of high frequency and high potential to take the place of anæsthetics in operations on the teeth. A d'Arsonval or Tesla apparatus with Oudin's resonator attached is used. One pole is connected to an electrode, moulded to fit the tooth, and lined with wet asbestos to counteract any heating effect on the tooth itself. Five minutes suffices to render insensible a tooth with a single fang. Molar teeth and those with several fangs require longer. If there is periostitis or inflammation of the root the process is less successful, and further study of these is called for. L. J.

1118. *Electricity and Plant Life.* **V. G. Heber.** (West. Electn. 30. p. 59, Jan. 25, 1902.)—This paper describes experiments showing the beneficial effect of passing a continuous or intermittent electrical current during the night, reversing the current every third or sixth day, and keeping the soil damp. A. D.

1119. *Lead Poisoning in a Child from the Use of a Pewter Mug.* **Variot.** (Revue Int. d'Électrothérapie, 11. pp. 259–264, Sept.–Oct., 1901.)—The author reports a case of extensive paralysis of the limbs in a child of four and a half years. The characteristic blue line seen upon its gums indicated the probability that the symptoms were due to lead. A search revealed no source of lead except a pewter cup which was used habitually by the child. This contained 75 per cent. of lead. The same cup had been used by an elder child at a former period, and this child also showed the blue line of lead upon her gums, although she had never had any paralytic symptoms. For comparison the pewter mugs used at the children's hospitals in Paris were analysed and found to contain 12·7 per cent. of lead. L. J.

REFERENCES.

1120. *Laws of Electric Energy.* **E. Carvallo.** (Comptes Rendus, 133. pp. 1195–1197, Dec. 23, 1901.)

1121. *Application of Lagrange's Equations to Electrodynamics.* **Liénard.** (Comptes Rendus, 134. pp. 163–165, Jan. 20, 1902.)—This is a paper pointing out a fallacy in Carvallo's argument against the general applicability of Lagrange's equations to electrodynamics. [See Abstracts Nos. 342 and 1120 (1902).] G. W. DE T.

1122. *Kelvin's Electric Measuring Instruments.* **M. Maclean.** (Inst. Elect. Engin., Journ. 31. pp. 117–137, Dec., 1901.)—The paper gives a brief description, with illustrations, of Kelvin's ammeters, voltmeters, and wattmeters. G. H. B.

1123. *Reflexion of Kathode Rays.* **J. Stark.** (Phys. Zeitschr. 3. pp. 161–165, Jan. 15, 1902.)—The paper is purely theoretical. It deals with the reflexion of kathode rays on the basis of the ionic theory. R. S. W.

1124. *Magnetokinetic Top.* **H. du Bois.** (Archives Néerlandaises, 6. pp. 581–592, 1901.)—This paper contains preliminary mathematical and quantitative work in pursuance of the investigation already qualitatively dealt with. [See Abstract No. 875 (1901).] A. D.

1125. *Magnetic Observations in South-East China.* **F. S. Chevalier.** (Terrestrial Magnetism, 6. p. 186, Dec., 1901).

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1126. *Atomic Weight of Uranium.* **T. W. Richards** and **B. S. Merigold.** (Amer. Acad., Proc. 37. pp. 365–395, Feb., 1902.)—In the "less inaccurate" previous work the results varied from 238 to 240. Zimmermann's mean determination of 239·6, from the oxidation of UO_2 to U_3O_8 is affected by the difficulty always experienced in forming a more from a less voluminous solid (sp. gr. $UO_2$10·2, $U_3O_8$7·3). Richards has previously investigated the errors caused by occlusion [see Abstract No. 593 (1899)], and has pointed out that reduction is usually much more complete than oxidation. As to Aloy's average, 239·40 [see Abstract No. 97 (1902)], from the ratio between the amounts of uranous oxide and of nitrogen gas obtained by heating uranyl nitrate and afterwards reducing in hydrogen, it is shown that the method is open to many inaccuracies. The author's work of four years, using the chlorides, bromide, iodate, and oxalate, is described, and details are given of their new determinations from the ratios $UBr_4 : 4AgBr$ and $UBr_4 : 4Ag$. The uranous bromide is prepared in a special subliming and bottling apparatus (figured), which is valuable for general purposes. At the high temperature bromine vapour attacks the porcelain tube, giving a little NaBr which has to be determined and allowed for. After oxidation by H_2O_2 the bromine was precipitated by silver nitrate in orange light, the exact end point being ascertained by means of the *nephelometer* (Amer. Acad. Proc., 30. 385, 1894). The original material was prepared by methods which have been shown by Crookes (Proc. Roy. Soc., 66. 409, 1900) to remove radio-active substance from uranium. Full details are given of the purification of the other substances used. As the mean value obtained, 238·53, is lower than has been previously accepted, several causes which might tend to lower it are discussed and dismissed, therefore "if oxygen is taken as 16·000, and bromine as 79·555, the atomic weight of uranium appears to be not far from 238·53." S. R.

1127. *Determination of the Molecular Weight of Liquids.* **A. Kistiakowsky.** (Jurn. Russk. Fisik. Chimicesk, Obscestva, 34. 1a. pp. 70–90, 1902.) —The Eötvös-Ramsay method of basing the determination of molecular weights on surface-tension measurements has so far been seldom made use of. The author suggests some simplifications of Ramsay's formulæ, testing them by calculating a large number of molecular weights from the data of other experimenters, the agreement with the theoretical values being fairly satisfactory. He next goes on to show a possible connection of these formulæ with Guldberg's views, the resulting law being as follows: Non-associated liquids, taken at their respective boiling-points, will exhibit approximately the same capillary energy. It is pointed out that this rule may, as well as Ramsay's formulæ, serve to ascertain whether a given liquid is in a state of association or not, though the series of hydrocarbons $C_nH_{2(n-x)}$ presents some striking exceptions. The author finally proceeds to make some measurements, especially on some terms of the above series, in order to test those deviations; it is suggested that these hydrocarbons may not represent chemical individuals, an hypothesis in favour of which, in some cases, chemical instances may be adduced. A. G.

1128. *Blue and Green Modifications of Sulphur.* **N. Orloff.** (Jurn. Russk. Fisik. Chimicesk. Obscestva, 34. 1a. pp. 52–67, 1902.)—The author draws the following conclusions from his own researches in connection with the work done by previous experimenters: (1) There are many reasons for presuming the existence of a particular modification of sulphur of a blue or green colour, the latter being possibly a mixture of the former with particles of yellow sulphur. This modification proves most unstable, and capable of existing only by means of a special kind of fixation on chlorides at the very moment of its being evolved from compounds, as well as in certain other inorganic and possibly organic compounds. (2) Among the circumstances favourable to the formation of this modification of sulphur, there is first of all the influence of dissociation and of rather incomplete reactions: the experiments of K. Gil on polysulphides of ammonium and alcohol, as well as on acetone, are quoted, those of Nöllner, and particularly Günther's researches with soldered tubes are mentioned, the latter ones promising to give interesting results on being repeated from the standpoint of the phase-rule. (3) As to the constitution of the molecule of blue sulphur, definite conclusions cannot, so far, be drawn; experiments with CdS and S_2Cl_2, however, in connection with Günther's investigations and with the colour of the body, would suggest that this molecule may be of an ozonic character, *i.e.*, built up of three atoms. It seems as though the preparation of the body in question should meet with similar difficulties as that of ozone. A. G.

1129. *Expansion of a Mixture of Hydrogen and Chlorine under the Influence of Light.* **P. V. Bevan.** (Cambridge Phil. Soc., Proc. 11. pp. 264–266, Feb., 1902.)—The initial expansion of a mixture of hydrogen and chlorine when exposed to light was observed by Draper, and attributed by Pringsheim to dissociation of hydrogen and chlorine molecules. The author, using Roscoe's apparatus (Phil. Trans., 1857, p. 359), decides that the phenomenon occurs only when there is combination of H and Cl, and is due to the heat evolved by that combination. D. H. J.

1130. *Influence of Sunlight on the Bromination of the Higher Methyl Benzenes.* **A. Korczyński.** (Accad. Sci. Cracovie, Bull. 1. pp. 14–18, Jan., 1902.)—The influence of sunlight in promoting substitution of bromine for hydrogen in the side chains is not manifest with the higher methyl benzenes. Thus hexamethylbenzene is not attacked at all under its influence, while pentamethyl benzene and durene give (at the ordinary temperature) ring-substitution products. When durene is *heated* with bromine, the latter enters the side chain; with pentamethyl benzene, under similar circumstances, the bromine enters the ring. The heating of hexamethyl benzene with bromine in a sealed tube leads to the production of hexabrom-hexamethyl benzene.
D. H. J.

1131. *Solubility of Zinc Hydroxide in Ammonia and Ammonium Bases.* **W. Herz.** (Zeitschr. Anorg. Chem. 30. 2. pp. 280–282, 1902.)—Previous researches of the author have dealt with equilibrium phenomena and quantitative precipitation of zinc. In connection herewith some experiments on the solubility of $Zn(OH)_2$ in ammoniac and ammonium bases were made, the main result being that to dissolve dried zinc oxide the number of basic molecules required will be greater as the base is more dilute. By substituting in the ammonia molecule one hydrogen atom by organic radicals the solubility will be diminished, the more so the higher the molecular weight of the substitute. Di-substituted amines will not dissolve zinc hydroxide. A. G.

1132. *Influence of Hydrochloric Acid upon Precipitation of Cuprous Sulphocyanide.* **R. G. van Name.** (Zeitschr. Anorg. Chem. 30. 1. pp. 122–130, 1902.)—The author, some time ago, recorded some researches on determination of copper by means of precipitation as cuprous sulphocyanide. As, however, in the discussion of the results, no distinction was made between free acid originally present and that remaining in solution on adding the precipitant, new measurements have proved necessary. In presence of free hydrochloric acid the precipitation of cuprous rhodanide by a slight excess of ammonium rhodanide is found to be imperfect, losses, however, not being considered, as long as the quantity of concentrated acid does not exceed 0·5 per cent. of the total volume. A practically perfect precipitation in presence of a considerable amount of acid can under certain circumstances be obtained by adding a considerable excess of ammonium rhodanide. The effect of adding larger quantities of ammonium bisulphite in presence of hydrochloric acid is very much the same as that of a partial neutralisation by means of ammonia, the acid forming ammonium chloride. If the amount of free acid remaining on adding the bisulphide be not too large, the ammonium chloride does not prevent the precipitation being complete. If the quantity of acid present be very large, it is advisable to take away most of it before precipitating the copper. A. G.

1133. *Avidity of Phenol.* **J. S. Plotnikow.** (Zeitschr. Elektrochem. 8. p. 73, Jan. 30, 1902.)—The author determines the avidity of phenol by the temperature changes which take place on the mixture of gram-equivalents of sodium sulphate and phenol; this was found to give rise to the absorption of 225 small calories. The results indicate that phenol is considerably weaker than acetic acid, and somewhat stronger than boric acid. From previous observations on the hydrolysis of potassium phenolate (Shields, Zeitschr. f. Phys. Chem. 12. 175) and from measurements of conductivity (Walker, Zeitschr. f. Phys. Chem. 32. 137), phenol was found to be considerably weaker than boric acid, and a little stronger than carbonic acid.

W. C. B.

1134. *Absorbents of Water.* **W. J. Busnikow.** (Zeitschr. Elektrochem. 8. pp. 72–73, Jan. 30, 1902.)—The author investigates the absorption of water by various bodies, by placing a weighed amount of the substance—for instance, sulphuric acid—in a glass vessel, over water in a dessicator. The increase in weight is divided by the number of hours between successive weighings. The quotient obtained is found neither to be constant nor to decrease constantly. The author supposes that the irregularities are due to the formation of hydrates. Many other substances were investigated in a similar manner, *e.g.*, $MgCl_2$, NaCl, Na_2CO_3. The abstract of the paper contains an unfavourable criticism of the author's experiments and conclusions.

W. C. B.

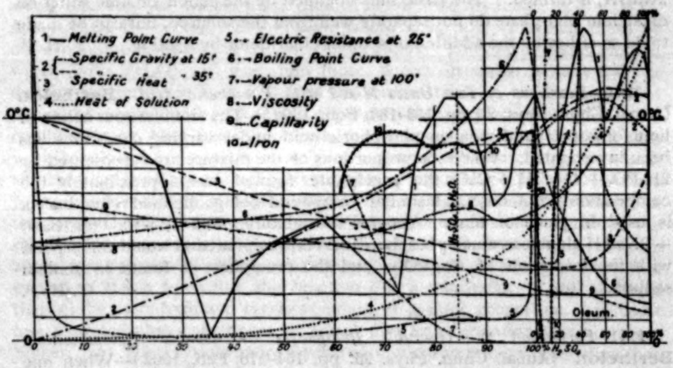
1135. *Catalysis.* **D. Turbaba.** (Zeitschr. Elektrochem. 8. pp. 70–71, Jan. 30, 1902.)—The author had already shown, in 1888, that the vapour of pure paraldehyde is not changed into aldehyde to any measurable extent, by continued heating to temperatures between 100° C. and 168° C. Kekulé and others have shown that the change takes place fairly rapidly in presence of certain substances; moreover it has been proved that those substances which bring about the change from paraldehyde to aldehyde at high temperatures also cause the opposite reaction, the polymerisation of aldehyde to paraldehyde, at lower temperatures. Bodies which show this behaviour include: HCl, HNO_3, H_2SO_4, $COCl_2$, SO_2, $ZnCl_2$, $CaCl_2$, $HgBr_2$, $HgCl_2$, B_2O_3, and $B(OH)_3$. These observations afforded the basis for a further research on Ostwald's theorem, that the presence of a catalyst does not affect the equilibrium-conditions of a reversible reaction. The research was made by means of dilatometers, kept at a constant temperature of 50·5° C. in an Ostwald thermostat. For the determination of the influence of various catalysts on the equilibrium between aldehyde and paraldehyde the author started with pure paraldehyde, to which varying masses of the different bodies were added, and the volume changes noted. With SO_2, $ZnSO_4$, HCl, oxalic acid, and H_3PO_4, the mean maximum increase was 8·19 per cent. of the original volume (variations between 8·10 and 8·34). With H^2SO_4, CCl_3COOH, $CdCl_2$, B_2O_3, $HgCl_2$, $ZnCl_2$, $CuSO_4$, and $CdSO_4$, the maximum was about 8·3 per cent. The author draws the conclusion in accordance with the above theory, that the equilibrium conditions are not influenced by the nature and mass of the catalyst present. There is equilibrium between aldehyde and paraldehyde in the liquid state, when the proportion of aldehyde lies between 33·36 per cent. and 35·23 per cent. In a second part of the research the author deals with the equilibrium between the two substances in various solvents—for instance water, acetone, and toluene. He finds that both the solvent used and the concentration affect the equilibrium to a large extent. With increasing dilution the equilibrium point is moved in the direction of a larger proportion of aldehyde, and the dissociating power of the solvent increases with its dielectric constant. Tables of data are given, and from these the author constructs an equilibrium formula $(1-X)/V = KX^3/V^3$, where $V =$ volume of the solution and $1-X$ the mass of undecomposed paraldehyde; values of K are given for water, acetone, and toluene. The author also finds that the accelerative action of various acids on the dissociation of paraldehyde in aqueous solution is approximately proportional to the concentration of their hydrogen ions. In the following table (1) is the conductivity of normal solutions of the acids, (2) influence on catalysis of methyl acetate, (3) inversion of cane-sugar, (4) splitting up of paraldehyde—

Acids.	1	2	3	4
HCl	100	100	100	100
CCl_3COOH	62·3	68·2	75·4	85·0
H_2SO_4	65·1	73·9	53·6	54·0
COOH . COOH	19·7	17·6	18·6	26·6
CH_2Cl . COOH	4·9	4·3	4·8	8·6

W. C. B.

1136. *True Density of Chemical Compounds.* **J. J. Kanonnikow.** (Zeitschr. Elektrochem. 8. pp. 69–70. Jan. 30, 1902.)—Part I. Hydrocarbons.—The true density of a body is the mass of that body which occupies a volume of 1 c.cm., when the molecules (considered as spheres) are brought into contact. In Lorentz and Lorenz's formula $R = (N^2-1)/(N^2+2) \cdot \frac{1}{d}$. N represents the index of refraction for rays of infinite wave-length, and R denotes both the specific refraction for these rays and also the real specific volume of the molecule. (Nernst, Theoretical Chemistry.) The reciprocal value $D = \frac{1}{R}$ represents the true density, and the number obtained by multiplying D by M, the molecular weight, is within fairly wide limits independent of the state of aggregation and the temperature. The value MD is especially suitable for throwing light on the structure of compounds owing to its constitutive character. The molecular density of a hydrocarbon $CnH_{Zn \pm m}$ can be obtained from the formula $MD = nc + (Zn \pm m)h + x\alpha + y\beta + z\gamma + v\delta - 8{\cdot}87$ where x = the number of double linkages, y of triple, z of rings, and v of "naphthalene' linkages. The value of MD for carbon as diamond is 67; for combined carbon (c in above equation) = 39·7. Hydrogen (h in above equation) 0·907 $\alpha = -5{\cdot}8$; $\beta = -8{\cdot}87$; $\gamma = +8{\cdot}7$; $\delta = -25{\cdot}14$. The value 8·87 is a constant representing the substitution of H in methane by CH_3. The formula is supported by many examples, and the differences from theory are less than 1 per cent. For benzene and its derivatives the results point to Kekulé's formula. Part II. Oxygen Compounds.—Although the values obtained for the true density are concordant for the hydrocarbons, those found for oxygen compounds show many irregularities. Firstly, the influence of the oxygen depends on its state of combination, whether as hydroxyl, carboxyl, or in ethereal combination; secondly, there are still irregularities which may depend either on polymerisation or the presence of tetrad oxygen. Finally tautomeric forms must be frequently assumed. These assumptions rob the results of much of their value; in some cases hexad oxygen must be present in order to reconcile the discrepancies found. W. C. B.

1137. *Physical Chemistry of Sulphuric and Fuming Sulphuric Acids.* **O. Sackur.** (Zeitschr. Elektrochem. 8. pp. 77–82, Feb. 6, 1902.)—The introduction of the contact method for the manufacture of sulphuric acid has led to fresh work on the physical properties of sulphuric acid. In the present paper the writer discusses this new work, of which a conception may be obtained from the following diagram :—



The writer considers the results from the point of view that we are not dealing here with simple solutions of H_2SO_4 in water, but rather with solutions in which there is more or less dissociation and hydration according to an equation such as $2H_2SO_4 \rightleftarrows H_2SO_4.H_2O + SO_3$. D. H. J.

1138. *The Critical State.* **J. J. Kanonnikow.** (Zeitschr. Elektrochem. 8. p. 70, Jan. 30, 1902.)—From considerations connected with the "true densities" of bodies [see Abstracts Nos. 931 and 932 (1902)] the author draws the conclusion that the equation for critical volume should be $\phi = 2b$, and not, as according to van der Waals, $\phi = 3b$. Further assuming Lorentz and Lorenz's formula for refractive power $r = (n^2 - 1)/(n^2 + 2)$, then $b = rd\sqrt{2}$ where d is the density. In order to obtain results agreeing with this formula, the author assumes the existence of tetrad oxygen and hexad carbon. From calculations made with the above formula, substances possess the same constitutional formulæ at the critical point as in dilute solution. W. C. B.

1139. *Neutralisation of Phosphoric Acid.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 145–158, Feb., 1902.)—When increasing quantities of lime water are added to a solution of phosphoric acid, a precipitate of the composition $CaHPO_4$ is formed when one hydrogen atom of the acid has been neutralised and when two molecular proportions of lime are present to one of the acid, the latter is almost completely precipitated. On continuing the addition of lime the latter is gradually absorbed by the precipitate with the formation of a compound containing 4CaO to every P_2O_5; this absorption of lime is very slow, even when large proportions of the base are present. It is noteworthy that a natural calcium phosphate, isoclase, occurs in which the relation of base to acid is $4CaO : P_2O_5$. When lime is added to phosphoric acid in presence of methyl orange, the colour of the latter changes when monocalcium phosphate, CaO, P_2O_5, is formed. If, on the other hand, the acid be added to the lime, the colour change of the indicator occurs when the composition is $2CaO, P_2O_5$. In the double decomposition between alkali phosphates and calcium salts, the precipitate does not in all cases consist always of the tricalcium salt, but sometimes of the dicalcium compound; whilst, when barium salts are employed, a double salt of the composition, P_2O_5, 2BaO, 2NaOH, is formed. The basic salts obtained by the action of lime water on dicalcium phosphate do not separate well from the solution, but can be made to do so either by the addition of sodium chloride or by heating. T. H. P.

1140. *Reactions of Two Bases Mixed with Phosphoric Acid.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 158–163, Feb., 1902.)—The simultaneous action of lime (or baryta) and soda on phosphoric acid under varying conditions has been investigated. When the proportions of the mixture are represented by $2H_3PO_4 + 4NaOH + CaO$, the precipitate formed has approximately the composition $(PO_4)_4\,Ca_3Na_6$, a similar compound being obtained when baryta is used in place of lime. Also for the mixture, $2H_3PO_4 + CaO$ (or BaO) $+ 2NaOH$, double as much phosphoric acid is precipitated as would correspond with the formation of $Ca_3(PO_4)_2$, and the precipitate is found to contain sodium. T. H. P.

1141. *Formation of Insoluble Phosphates by Double Decomposition.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 164–176, Feb., 1902.)—When one molecular proportion of disodium phosphate is mixed in the cold with three of silver nitrate, all the silver present is precipitated. The acidity of the filtrate towards phenolphthaleïn and methyl orange indicates the formation of 1 mol. of the primary sodium phosphate from 2 mols. of the secondary. The precipitate does not, however, consist entirely of pure trisilver phosphate, but contains a small quantity of the disodium salt which is only very slowly and imperfectly removed by washing. When 1 mol. of disodium phosphate and 2 mols. of silver nitrate are mixed in solution, one-sixth of the silver remains dissolved as primary phosphate, together with free phosphoric acid and sodium nitrate; the precipitate consists mainly of trisilver phosphate, but retains sodium phosphate. The author considers that the sodium phosphate which occurs admixed with the precipitated silver phosphate is present in the form of a double salt, and that in chemical equilibria of this type such double salts must play a part. T. H. P.

1142. *Chemical Equilibria between Phosphoric Acid and Chlorides of the Alkaline Earth Metals.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 176–196, Feb., 1902.)—The author describes a number of experiments in which he has determined the alkalinity or acidity of mixtures, both with and without the addition of various proportions of sodium hydroxide, of (1) phosphoric acid and alkaline earth chlorides, and of (2) mono- and di-sodium phosphates and chlorides of the alkaline earth metals. Exact neutrality is seldom obtained with the proportions of the reacting substances corresponding with simple equations. In some cases the attainment of equilibrium requires time, whilst in others the result obtained varies with the time during which the precipitated phosphate remains in contact with the liquid. The amount of alkaline earth required to neutralise 1 mol. of phosphoric acid varies, according to the conditions, from 2 to 4 equivalents. T. H. P.

1143. *Heterogeneous Equilibrium between Mixed Crystals of Isomorphous Saline Hydrates.* **G. Bruni** and **W. Meyerhoffer.** (Accad. Lincei, Atti, 11. pp. 185–190, Feb. 16, 1902.)—One of the authors [G. Bruni; *cf.* Abstract No. 2423 (1901)] has already given a general theoretical treatment of the different types of heterogeneous equilibrium. In the present paper, with a view to the early publication of experimental data, the authors consider the special case of mixtures of two isomorphous substances A and B, which, when dissolved in water, give, each, one or two hydrates, $A + x . H_2O$, $A + y . H_2O$, $B + x . H_2O$, $B + y . H_2O$, where x is $> y$, of which those of corresponding composition are also isomorphous. The two hydrates rich in water (with $x H_2O$) will pass into those poorer in water (with $y H_2O$) at definite temperatures T_A and T_B, and the temperatures of transformation of the mixed crystals with $x . H_2O$ will depend on the composition of these. For equilibrium we have four phases, viz., mixed crystals with $x . H_2O$ and with $y . H_2O$, solution and vapour—which for a system of three components constitutes a series of non-variant systems without any multiple point. The curve to express the change of composition of the $x . H_2O$ crystals with change of temperature will, therefore, be a continuous one. We may consider the relation between the mixed crystals with $x H_2O$ and those with $y . H_2O$, by applying a theorem of Gibbs, according to which, at each temperature that system is stable for which the function ζ is a minimum. It will be found that (*a*) the more hydrated crystals contain in greater proportion than those less hydrated, that component of which the transformation temperature is higher. (*b*) The crystals more hydrated contain in greater proportion than those less hydrated, that component which, when added to the system, raises the temperature of transformation. D. H. J.

1144. *Chemical Equilibria between the Ammonium Phosphates and Barium Chloride.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 197–200, Feb., 1902.)—In a manner similar to that described in Abstract No. 1142 (1902) the author has examined the behaviour of three ammonium phosphates towards barium chloride. The results given are, however, not very accurate, owing to the dissociation of the ammonium phosphates. T. H. P.

1145. *Chemical Equilibria between the Ammonium Phosphates and Magnesium Chloride.* **Berthelot.** (Annal. Chim. Phys. 25. pp. 200–204, Feb., 1902.)—Investigation of the reactions between phosphoric acid, ammonia and magnesium chloride shows that the equilibrium is very complicated, and also depends in a very high degree on the conditions under which the compounds are mixed. T. H. P.

1146. *New Measurements on Absorption.* **W. Müller-Erzbach.** (Deutsch. Phys. Gesell., Verh. 4. 3. pp. 35–38, Feb. 7, 1902.)—Measurements on the absorption of the vapours of water and carbon disulphide by aluminia or ferric oxides. The novelty consists in keeping the absorbing substance at a slightly higher temperature than the liquid which is emitting the vapour, so that condensation due to cooling is avoided. It is found that water vapour can drive our previously absorbed carbon disulphide, while the latter is scarcely at all absorbed if the substance has previously taken up its full complement of water vapour. The latter is much more strongly held. In fact, if the substance has been only partially saturated with water, it can take up some carbon disulphide, but the latter appears only to form an external layer, and can be again driven out without the absorbed water being affected (except to a very slight degree). The author considers that his measurements point to a much greater value for the radius of the sphere of molecular attraction than that usually assumed. F. G. D.

1147. *Equation for the Osmotic Pressure of Concentrated Solutions.* **C. H. Wind.** (Archives Néerlandaises, 6. pp. 714–726, 1901.)—The author bases his theory, like that of van der Waals, on the virial equation, and arrives, by a process of reasoning which is too long for reproduction, at an equation of the form—

$$\left(N + \frac{a-a'}{V^2}\right)\left(V - \theta\frac{b^2}{V}\right) = RT$$

where $N =$ osmotic pressure;
$V =$ volume of solution containing one grm. mol. solute;
$b =$ actual volume occupied by solute;
$a, a', \theta =$ constants.

This equation, compared with the equation of van der Waals, present two novelties. In the first place the term $\frac{a-a'}{V^2}$ may be *negative*, and secondly the term $\theta\frac{b^2}{V}$, as it contains the volume V in the denominator, only becomes appreciable for small volumes. The author tests his equation by means of data collected for concentrated cane-sugar solutions by Ewan [see Abstract No. 674 (1900)] and also by means of measurements of the e.m.f. of cells of the type Cd-amalgam 1 — $CdSO_4$ solution — Cd-amalgam 2 carried out by H. G. Bijl in his thesis for the Doctorate (Amsterdam, 1901). In both cases it is found that the equation reproduces the experimental results with great accuracy. This test only means that an equation of the *form* given can be employed to reproduce the experimental results, for the values of $a - a'$ and θb^2 are obtained by calculation from two of the experimental numbers. F. G. D.

1148. *Lead-Tellurium Alloys.* **Fay and Gillson.** (Zeitschr. Elektrochem. 8. p. 54, Jan. 23, 1902.)—After the separation of copper and silver from the Colorado copper-ore, a residue consisting largely of sodium tellurite, and in addition containing selenite and silicate of sodium, is obtained. From this residue metallic tellurium is easily prepared. Melted tellurium resembles silver in colour, and antimony in general physical properties, is capable of being polished, and is very brittle. The authors endeavoured to employ tellurium commercially, and made alloys with lead and antimony. These are fusible with difficulty, in some cases only before the blow-pipe. The combination of lead and tellurium is attended with a large evolution of heat. W. C. B.

1149. *Thallium Alloys.* **N. Kurnakow** and **N. Puschin.** (Zeitschr. Elektrochem. 8. pp. 54–55, Jan. 23, 1902.)—The authors have investigated the solidifying-points of alloys of thallium with sodium, potassium, cadmium, tin, and mercury. They express their results by means of curves, taking the molecular percentages of thallium as abscissæ, and the freezing-points of the various mixtures as ordinates. In the case of sodium the solidifying-point at first falls on addition of thallium, and at the lowest-point reached a mixture of sodium and an indefinite alloy, Na_xTl (x varying between 2 and 6) separates. There is now a rise of freezing points, with breaks corresponding to the alloys Na_2Tl and NaTl, until the highest point is reached, a little above the melting-point of pure thallium. From this point the curve falls sharply and then rises to the freezing-point of thallium as an almost straight line. The curve for K-Tl alloys is very similar, except that there is no alloy with a lower solidifying-point than that of pure potassium. The mixture having the highest freezing-point, about 40° C. above that of pure thallium, corresponds with the composition KTl. By comparison with former results obtained by one of the authors, the conclusion is drawn that, in its alloys with Na, K, Sn, and Cd, Tl behaves as a heavy metal; whilst when alloyed with Hg, Pb, and Bi, it plays the part of an alkali metal. W. C. B.

1150. *Sodium-Potassium Alloys.* **N. Kurnakow** and **N. Puschin.** (Zeitschr. Elektrochem. 8. p. 55, Jan. 23, 1902.)—The authors give their results in the form of a curve of melting-points of varying mixtures of the two metals (see preceding Abstract). There are two distinctive points on the curve; one a transition-point corresponding with the composition Na : K = 1·5 : 1, and the other a eutectic-point when the composition is Na : K = 1 : 2. The authors conclude that when the proportion of sodium is large, an isomorphous mixture of the two metals separates, and at the eutectic-point an alloy of the probable composition Na_3K_2, but possibly Na_2K is found. W. C. B.

1151. *Aluminium.* **E. Wilson.** (Inst. Elect. Engin., Journ. 31. pp. 321–333; Discussion, pp. 334–339, Feb., 1902.)—The purest (99·6 per cent.) aluminium obtained commercially contains traces of iron and silicon. Commercial wire returns to its original length after the application of any stress up to 16,000 lbs. per sq. in. As soon as the proportion of copper (1·5 to 2 per cent.) is sufficient to give a breaking load of 40,000 and limit of elasticity of 33,000 lbs. per sq. in. the specific resistance rises to 3·3 from $2·76 \times 10^{-6}$ ohms for pure commercial aluminium at 15° C. The temperature coefficient falls to 0·0030 from 0·0040: the linear coefficient of expansion is 0·000024, as against 0·0000234. Not much is gained in tensile strength by increasing the quantity of copper from 1·5 to 2·5 per cent. The alloy containing 1·29 per cent. Ni and 1·08 per cent. Cu gives a limit of elasticity 36,000 lbs. per sq. in. Its specific resistance is $3·41 \times 10^{-6}$ legal ohms at 15° C. Many of these alloys when erected between two horizontal points of support 120 ft. apart, the unstretched length of the wire being equal to the distance between the points of support, and the temperature the standard temperature, are superior to copper for a given fall of temperature from a standard temperature. The small diameter of the G.P.O. experimental wires[1] may have something to do with the breaks which occurred, because two separately strung wires of equal diameter are not so good as one wire of the $\sqrt{2}$ diameter, although the total conductivities are the same in the two cases. Aluminium effects a saving in transport, since for the same conductivity only half the weight of aluminium need be used.

The following table, as well as two valuable tables of alloys, are given:—

Number of Wire.	Specific Resis. in 10^{-6} legal ohms at 15° C.	Conductivity in terms of Matthiessen's Standard at 15° C.	Temperature Coefficient 0° C. 100° C.	Linear Coefficient of Expansion per 1° C. between 18 and 103° C.	Specific Gravity.	Limit.		Break.		E.		Percentage Elongation on 350 mm. including break.	Percentage reduction of area at break.
						Load in lbs.	Tons per sq. in.	Load in lbs.	Tons per sq. in.	Lbs. per sq. in	Tons per sq. in.		
Averages of three specimens.	2·762	61·5	0·00405	0·0000234	2·715	250	8·65	—	12·60	8,512,000	3,800	1·86	73·6
Averages for two specimens.	2·762	61·5	0·00405	0·0000231	2·715	250	8·65	342	12·24	8,512,000	3,800	2·32	76·7
Averages for three specimens.	2·762	61·5	0·00393	0·0000230	2·715	95	3·4	182	6·44	1,683,240	751	22·5	88·2

M. O'G.

1152. *Ionisation, Ionic Velocities, and Atomic Sizes.* **W. Sutherland.** (Phil. Mag. 3. pp. 161–177, Feb., 1902.)—Thomson and Nernst have suggested that ionisation of a solute may be due to the high dielectric capacity of the solvent, others that it is caused by the association of the molecules of the solvent; the author proposes that high dielectric capacity, high power of ionisation, and tendency to molecular association may be all due to what he calls the latent valency of certain atoms. Thus, in the case of water, replacing the usual chemical bonds by pairs of electrons, he gives a symmetrical representation of the trihydrol molecule, in which oxygen appears as a tetrad different from the ordinary chemical tetrad in that of the four electrons attached to it three are negative and one positive. When this is dissociated, one of the negative electrons and the positive electron tend to form a neutron, but this takes time, during which they are at a certain average distance apart and have an average electric moment greater than that of the neutron. In discussing the behaviour of binary electrolytes, the need for taking account of viscosity is shown and a formula is developed for the specific molecular conductivity, which shows its dependence on the dielectric capacity of the solution. Polymerisation is suggested as the reason why Ostwald's law applies to the ionisation of weak acids and not to binary electrolytes, *e.g.*, for acetic acid the law probably is the expression of equilibrium between di-acetic acid and the products of its dissociation, while the polymerisation of sodium acetate is more unstable in the presence of water. Graphs are given for several solutions, in which xi is plotted against $m^{\frac{1}{2}}$, i being the degree of ionisation of the solution, m its strength, and x a factor introducing the dielectric capacity, which differs little from unity for small values of m. These graphs are of parabolic form, but distorted for small values of m. In conclusion it is shown how the size of the molecule may be calculated from the observed ionic velocity, and suggested that this may be useful in the estimation of the molecular weights of large organic ions. W. E. T.

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[1] Cp. Journal, I.E.E., 1901, vol. xxx. p. 359.

1153. *Melting-points of Dissociating Compounds.* **F. A. Lidbury.** (Zeitschr. Phys. Chem. 39. pp. 453–467, Jan. 17, 1902.)—By means of a slightly modified Beckmann freezing-point apparatus the author determined the temperature-concentration curves in the neighbourhood of the melting-point for the following systems:—(*a*) $CaCl_2 . 6H_2O$ (solid), $CaCl_2 + xH_2O$ (liquid); (*b*) $C_6H_5NH_2 . C_6H_5OH$ (solid), $C_6H_5NH_2 + C_6H_5OH$ (liquid). The curves run through the melting-point parallel to the concentration axis, and show no "breaks." The crystallisation velocity was measured for the following: (*a*) $CaCl_2 . 6H_2O$ from solutions of $CaCl_2$ + 5·8 to 6·5 H_2O, (*b*) $C_6H_5NH_2 . C_6H_5OH$ from mixtures of aniline and phenol, (*c*) sulphuric acid from solutions of sulphur trioxide and water in sulphuric acid. The velocity changes steadily in value with change of concentration in the first two cases; sulphuric acid, on the other hand, shows a well-marked maximum. D. H. J.

1154. *Dissociation of Chloral Hydrate and Alcoholate in Solution.* **L. Bruner.** (Acad. Sci. Cracovie, Bull. 9. pp. 464–478, Dec., 1901.)—The author made ebullioscopic determinations of the molecular weights of these substances in a large number of solvents, with the result that in no case investigated, except in the case of the acetic acid solutions examined by Beckmann, is there any perceptible dissociation of either alcoholate or hydrate of chloral at the boiling-point of the solvent. On the contrary, an association was found for chloral and its hydrate in nitrobenzene, and for chloral alcoholate in methyl iodide, ethyl bromide, and carbon bisulphide. D. H. J.

1155. *E.M.F. of Daniell Cell.* **J. Chaudier.** (Comptes Rendus, 134. pp. 277–279, Feb. 3, 1902.)—If the copper sulphate is maintained saturated, and the zinc sulphate varied in concentration, the e.m.f. at first increases with the concentration, reaches a maximum when the solution contains ½ per cent. of zinc sulphate, and then diminishes. The temperature coefficient is at first negative; it becomes zero for a solution of about the above concentration, and then positive, but again becomes zero at about 7½ per cent., and finally negative once more. These results are discussed with reference to the Nernst and Helmholtz equations. W. R. C.

1156. *Gas-Cell Measurements.* **E. Bose.** (Zeitschr. Anorg. Chem. 30. 3. pp. 406–408, 1902.)—This is a remark on V. Czepinski's paper [see Abstract No. 920 (1902)]. The author gives a superior limit of 1·154 for the e.m.f. of the hydrogeno-xygen cell (at 25°), and suggests taking the mean value of this and 1·12 as the most probable figure. He then corrects a slight misunderstanding in Crepinski's quotation of his views. A. G.

1157. *Electrolytic Production of Crystalline and Spongy Tin.* **W. Pfanhauser, Jr.** (Zeitschr. Elektrochem. 8. pp. 41–43, Jan. 16, 1902.)—

The author endeavours to find some method for depositing firm coatings of tin on other metals. The chief advantages of tinning in the wet way over the present method of using a bath of the molten metal, are the lower cost and the less liability of injuring the more delicate parts of the objects by filling them with tin. The bath given by von Roseleur, consisting essentially of stannous chloride and sodium pyrophosphate, was found by the author to deposit spongy tin after a few minutes' working. A large increase of concentration and altering the temperature and current produced no particular improvement. Stirring the solution caused the spongy tin to separate after a longer interval. The author finds that with increase of concentration of stannic and stannous chloride beyond normal solutions the production of spongy tin ceases when currents of small density are used; whilst with a current-density of over 1 ampere to 100 sq. cm. crystalline tin is formed. The production of thick coatings of the metal is possible by the use of very concentrated tin salt solutions, which contain no kations that could produce strongly dissociated solutions round the kathode. It is also necessary that there should constantly be a sufficient quantity of tin ions, and therefore of tin salt, in the neighbourhood of the kathode; for this reason the current-density must be kept small and the liquid stirred. The author also discusses the theoretical import of his experiments, and further describes two crystalline varieties of tin. W. C. B.

1158. *Electrochemistry of Double Salts.* **W. Kistiakowski.** (Zeitschr. Elektrochem. 8. pp. 71–72, Jan. 30, 1902.)—In this research the author's aim is to prove that the dissociation of salts in aqueous solutions may give rise to complex kations, as well as complex anions; *i.e.*, in addition to Hittorf's scheme, $M_2X_2 = M^{\cdot} + MX'_2$, the following may also occur, $M_2X_2 = M_2X^{\cdot} + X'$. Hellwig (Zeitschrift für anorg. Chemie. 25. 157) investigated the conditions of formation of the double salts AgI, $AgNO_3$ and 2AgI, $AgNO_3$, and found that the first exists in $AgNO_3$ solutions up to 0·712 normal, while the second is formed in concentrated solutions. The author examines the series Ag | $AgNO_3$(AgI), $AgNO_3$ concentrated | $AgNO_3$ | Ag, and finds that the difference of potential, varying from 1·6 to 8·6 millivolts with the concentration, agrees within the limits of experimental error with the value deduced from Nernst's formula $\pi = 0{\cdot}0608 \log \frac{C_1}{C_2}$. From the increased tendency of Ag to dissolve in $AgNO_3$ solutions on the addition of AgI, the author concludes that $Ag_3I^{\cdot\cdot}$ ions are present in the solution. Measurements are also given of the e.m.f. of the series M | KCN | MX | M, where M is a metal. The results are in accordance with theory, the observed e.m.f. being a measure of the tendency to form double salts. The author determines the transport numbers of various complex ions, and gives results of measurements, by an improved method, on the salts $Ag_3Cr(C_2O_4)_3$, $K_4Fe(CN)_6$, and $K_3Co(CN)_6$. The paper contains also a discussion of the chemical and electrochemical theories of formation of salts. W. C. B.

1159. *Electrolytic Oxidation of p-Toluic Acid.* **H. Labhardt** and **R. Zschoche.** (Zeitschr. Elektrochem. 8. pp. 93–96, Feb. 13, 1902.)—The authors give the results of their investigations on the electrolytic oxidation of *p*-toluic acid dissolved in alkali in order to escape the secondary reactions taking place when a methyl group is oxidised in presence of strong sulphuric acid. The products of the reaction are terephthalic acid, carbon dioxide, and monoxide. The kathode compartment of the electrolytic cell was shut off gas-tight from the anode compartment, so that the oxygen given off could be collected and measured; the difference between this quantity and the total oxygen evolved, determined by means of a control cell, represents the amount used up in oxidising the toluic acid. The best results are obtained with a spiral of copper wire as kathode and an anode of platinum. The influence exerted by the concentration of the acid, the amount of alkali present, the current density and the voltage on the oxidation were studied. It is not possible to convert *p*-toluic acid into terephthalic acid by the quantitative amount of oxygen, but conditions must be so chosen that a large percentage of the gas evolved takes no part in the reaction. T. H. P.

1160. *Measurement of Electrolytic Diffusion, Transport Numbers, and Mobility of the Ions.* **P. Straneo.** (Accad. Lincei, Atti, 11. pp. 171–177, Feb. 16, 1902.)—In the Atti R. Accad. Lincei, 1902, v. 11. i. pp. 58–65, a method was developed both mathematically and practically for measuring the electrolytic velocity constants in the case of complete dissociation of the electrolyte. In the present paper it is shown that an application of the elementary law of Fick for hydro-diffusion enables the theory, and therefore also the practice of measurement, to be immediately extended to the case of incompletely dissociated electrolytes. D. H. J.

1161. *Conductivity of Solutions of Mixed Electrolytes.* **H. Wolf.** (Zeitschr. Elektrochem. 8. pp. 117–119, Feb. 20, 1902.)—The influence of a third substance on the conductiyity of an electrolytic solution is determined by (1) a change of ionic mobility; (2) a change in the degree of dissociation; (3) an isohydric influence, depending on double decomposition of the two solutes. Solutions of NaBr and of KCl of 0·0282N strength behave in a similar manner when mixed with acetic acid; the decrease of conductivity amounts to 8·5 per cent. per mol. HAc per litre, and is due almost exclusively to increasing viscosity causing a decreasing ionic mobility. In a footnote, it is pointed out by Abegg that, on applying this correction to acetic acid itself, Ostwald's law of dilution holds good, not only to 0·2N, but up to N strength. In the case of N/2 solutions of KCl a *further* decrease of 0·5 per cent. occurs on adding 1 mol. HAc, owing to decreasing dissociation. A still larger decrease occurs when monochloroacetic acid is used in place of acetic acid, as here double decomposition occurs to an appreciable extent according to the equation $KCl + H\bar{A} = HCl + K\bar{A}$. By comparing such a series of mixtures the three causes of decreasing conductivity can be largely separated. Curves are given for the three cases referred to, for mixtures with alcohols and with tartaric acid, and also for solutions of zinc sulphate. T. M. L.

1162. *Voltameter for Small Currents.* **R. A. Lehfeldt.** (Phil. Mag. 3. pp. 158–159, Jan., 1902.)—The voltameter described by the author is suitable for the measurement of long-continued currents of very small magnitude, and is constructed as follows: A glass tube of from 0·5 to 1·5 mm. bore is provided with a pair of platinum electrodes sealed in near the ends, the latter being then drawn out to a small diameter. By means of a water-pump, the tube is then filled with mercury throughout except for one drop of mercurous nitrate solution in the middle. The tube is placed vertically, the upper portion of mercury being made the anode and the lower the kathode. The drop of solution creeps up the tube at a rate proportional to the current flowing, the movement being measured by any convenient scale, preferably one etched on the glass, with or without a micrometer. The solution is prepared by weighing out about 26·3 m. grms. of mercurous nitrate per c.c. of water and adding enough nitric acid to dissolve the basic salt formed. The current density may have any value up to 10 or 15 milliamperes per sq. cm. but above this, polarisation is caused; a tube of 2 sq. mm. section will hence take 0·3 milliampere. Using a current of 1/12,000 ampere with the instrument constructed by the author, the observed rate of movement was 1 micrometer division (0·0785 mm.) in 1·073 hours, the calculated rate being one division in 1·067 hours. The details to be attended to in the construction of the voltameter are given. T. H. P.

1163. *Improved Electric Furnace for Laboratory Use.* **S. A. Tucker** and **H. R. Moody.** (Chem. News, 85. pp. 75–76, Feb. 14, 1902. From Journ. Amer. Chem. Soc. vol. 23, No. 7.)—The Moissan furnace is troublesome on account of its liability to crack in use, unless perfectly dry, and owing to the difficulty of using it for more than one operation. The authors substitute carbon bricks for the lime blocks, the electrodes being prevented from contact with the end walls through which they pass, by renewable collars of asbestos ¼ in. thick. The bricks are 12 in. × 4 in. × 2 in. luted with Dixon stove paste, and are bound with iron bands insulated from them by pads of asbestos, the carbon electrodes are surrounded at the free ends with copper sleeves lined with copper gauze, tightened with set-screws, which carry copper lugs holding the flexible cables. The ends of the electrodes projecting outside the furnace are protected from combustion either by water-jacketing or by heavily plating with copper. Using a single-arc furnace with a polar separation of 18 mm., and sufficient resistance in circuit, a current of 125 amperes × 70 volts = 8,750 watts was used. With a two-arc furnace, without resistance, the current was at first 175 amperes × 90 volts, but a few moments later was 125 amperes × 100 volts. A furnace with a working space 6 × 4 × 2 in., and with electrodes 1 in. in diameter, is suitable for use with currents up to 300 amperes × 70 volts. W. G. M.

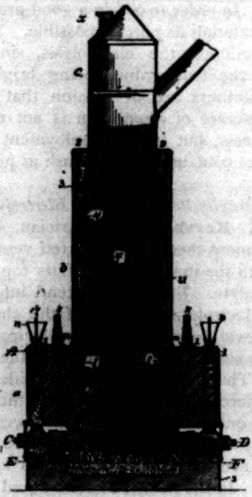
1164. *Modified Moissan Electric Furnace.* **L. Liebmann.** (Zeitschr. Elektrochem. 8. pp. 125–128, Feb. 27, 1902.)—An account is given by the author of an electric furnace of the Moissan type, which can easily be put together by means of ordinary stoneware sections as used for enclosing electric cables in Germany. The furnace is of the resistance type, and semicircular segments of stoneware serve as the bed and surrounding medium of the furnace. An easily arranged water resistance, as well as the other parts of the furnace, is shown by illustrations. Altogether the paper contains a number of useful hints for experimental work in this direction. O. J. S.

1165. *Experiments on the Manufacture of Aluminium.* **F. Haber** and **R. Geipert.** (Zeitschr. Elektrochem. 8. pp. 1–8, Jan. 2, and pp. 26–33, Jan. 9, 1902. From the Chemischtechnischen Institut at Karlsruhe.)—The authors produce aluminium by means of an experimental electric furnace. The furnace consists essentially of a block of artificial carbon in which a bath of the proper dimensions is cut. That employed by the authors is circular and is 70 mm. deep. The diameter at the bottom is 113 mm., and at the top 138 mm. Into this bath is lowered, by means of fine adjustments, a cylindrical carbon anode 66 mm. in diameter. Both carbons were of the best quality, and were made from materials as free as possible from ash. In the first experiment, 1,000 grms. of powdered cryolite and 200 grms. of alumina were fused in the bath by means of an electric arc. 7 volts and 400 amperes were employed, the experiment lasting 290 minutes. During the run an additional 885 grms. of cryolite and 927 grms. of alumina were added. The average current strength was 310 amperes. 270 grms. of aluminium were obtained, the current efficiency being 54·3 per cent. The e.m.f. was 7 volts at the beginning and gradually rose to 10 volts at the finish, the mean value being 8·5 volts. Consequently the consumption of energy was 63 e.h.p.-hours per kg. of aluminium. A considerable quantity of aluminium was oxidised. The purity of the aluminium obtained and its mechanical properties were satisfactory. The results may be summarised as follows: The preparation of pure aluminium, from a mixture of cryolite, aluminium fluoride, and alumina may be easily accomplished in a furnace as above, using a current of 300–400 amperes at 7–10 volts, the kathode current density being 3 amperes per sq. cm. In order to obtain a good product, it is most important to start with the raw materials as pure as possible. The high percentages of aluminium fluoride facilitates the electrolysis, since the bath is thereby rendered more fluid, the temperature being bright red-heat. From the results obtained, the authors are of opinion that the modern successful electrochemical manufacture of aluminium is not due to secret alterations in the electrolytic process, but to the employment of purer raw materials and to the use of anodes containing as little ash as possible. O. J. S.

1166. *The "Bell" Gravity Process for the Electrolytic Production of Alkalies and Chlorine.* **J. B. C. Kershaw.** (Electrician, 48. pp. 618–619, Feb. 7, 1902.)—In this arrangement there is an inverted vessel or "bell" mounted in the electrolytic cell, with the inner surface of its top a short distance above the level of the electrolyte. Two pipes extend into this bell, one opening above the level of the electrolyte, to carry off the chlorine, and the other in the centre below this level, for supplying the electrolyte to the cell; there is an overflow pipe in one side of the outer cell for the outlet of the solution of caustic alkali formed. The anode is mounted inside the bell, some distance above the lower edge thereof, immediately below the supply pipe, whilst the kathodes are mounted outside just above the lower edge of the bell. By admitting the electrolyte above the anode, it is mixed with the liquid around the anode by the gas evolved at that place, thus keeping this liquid at a constant concentration. In the bell, the anode liquid saturated with anion is superposed above a certain part of the kathode liquid, which, beginning with a minimum strength of alkali, becomes more concentrated and specifically heavier from this point downwards, and at the lower edge of the bell has its maximum strength of alkali, which is identical with that contained in the liquid throughout the kathode compartment outside the bell. The fresh electrolyte is supplied at such a rate as to maintain these conditions. Ordinary thick lamp carbons are used as anodes, and are stated to last 1¾ to 2 years. The costs for caustic potash are as follows: Capital outlay on a plant producing 14,000 kg. of 90 per cent. caustic potash and 21,600 kg. bleaching powder per day with 4 × 600 h.p. generating units £150,000, working capital £10,000, making a total of £160,000. The working costs per day are: Electrical energy (1,400 kw. for 23 hours) £25 7s. 6d., coal and steam for concentrating caustic liquor £6 16s. 6d., potassium chloride (17,200 kg.) £166 12s., caustic lime (18,400 kg.) £10 11s. 9d., wages £23 12s. 6d., repairs £18 7s. 6d., packages £17 10d., general expenses (20 per cent. on above) £51 18s. 5d., depreciation (7 per cent. on £150,000) £28 13s. 8d., interest (5 per cent. on £160,000) £21 16s. 10d., making a total daily cost of

£871 6s. 8d. This process is being worked at Aüssig, in Austria, and at Bitterfeld and two other places in Germany. Costs are also given for caustic soda. C. K. F.

1167. *Electric-furnace Method of Producing Carbon Disulphide.* **E. R. Taylor.** (Elect. Rev. N.Y. 40. pp. 143–145, Feb. 1, 1902.)—An illustrated description of the process and apparatus for producing carbon disulphide, worked out and patented by E. R. Taylor. The process has already been tested on a commercial scale, and over 100 tons of carbon disulphide are stated to have been produced. A large plant is now being erected at Penn Yan, New York State, and a water-power at this spot is being developed for operation of the furnaces. Coke and sulphur are the raw materials of the manufacture. The coke is charged into the upper portion of the furnace, which is shown in sectional elevation in the illustration. The sulphur is fed in at the annular openings in the lower part of the furnace, and is melted and vapourised by the electric current passing over the hearth of the furnace by the electrodes C and D. The sulphur vapour rising up through the heated coke combines with it, and the carbon disulphide vapour is drawn away to the condensers. As the furnace is of the resistance type, and the walls are well protected by sulphur and coke, there is not any appreciable wear and tear upon the lining of the hearth, and one furnace is expected to run several months before needing repairs. A further advantage of the electrothermal process is that it can be worked continuously, whereas the older process involved stoppages for charging and resetting retorts. The present output at Penn Yan with one furnace is 8,000 lbs. carbon disulphide per 24 hours, and apparently 330 kw. electric energy are being utilised in order to obtain this result. An output of 20,000 lbs. per 24 hours is expected when the works are completed. J. B. C. K.



1168. *An Electrolytic Cyanide Vat.* **Irwin.** (Eng. & Mining Journ. 73. p. 112, Jan. 18, 1902.)—This invention consists of a series of tanks to retain the solutions, provided with an endless conveyor belt for carrying the ore from end to end of the series through the plant. The several tanks are similar in form, shallow, and each is provided with an inclined end, discharging into the next tank. The first tank contains caustic soda solution, the middle ones of the series cyanide, and the last tank is a filter designed to renew the exhausted cyanide solution. In the middle vats the conveyor functions as anode, and kathodes are inserted in these vats to receive the deposited metals. These kathodes are flat plates fixed parallel to the anode, one above and one below it. Wooden blocks fixed on metal cross-bars serve to stir up the ore lying on the conveyor as it passes through the cyanide solution. The novelty of the apparatus lies in its structural details, not in the principle. J. B. C. K.

1169. *The Substitution of Sodium Hydrogen Sulphate by Normal Sodium Sulphate in Brass-Plating Baths.* **A. Fischer.** (Elektrochem. Zeitschr. 8. pp. 247–248, Feb., 1902.)—The author has made experiments on a cyanide brass-plating bath advocated by von Pfanhauser (Elektroplattierung, 4. Aufl. S. 346.)—He finds that the mixture employed of sodium carbonate and sodium hydrogen sulphate may be advantageously replaced by an equivalent quantity of normal sodium sulphate. The two former salts do not react completely at the dilution used in the bath, and the unchanged sodium hydrogen sulphate causes a very poor deposit of brass. For copper-plating, on the other hand, a little of the acid sulphate may be added with advantage. The author recommends the following for brass-plating: 1 litre water, 4 grms. Na_2CO_3 (dried), 44 grms. Na_2SO_4 (dried), and 2 grms. NH_4Cl dissolved together, afterwards adding 20 grms. potassium copper cyanide, 20 grms. potassium zinc cyanide, and 1 grm. potassium cyanide. [See also Abstract No. 353 (1902).] W. C. B.

REFERENCES.

1170. *Physico-Chemical Measuring Apparatus.* **A. S. Cushman.** (Chem. News, 85. pp. 76–77, Feb. 14, 1902. From the Journal of the American Chemical Society, 23.)—A Kohlrausch-Ostwald conductivity-cell is described, in which the movable electrodes can be rigidly secured by means of screws. A modification of the Ostwald burette-calibrator is also described, in which the 2 c.c. pipette is provided with a scale instead of a single mark, so that the exact relative volume of each 2 c.c. of the burette can be rapidly determined without weighing. T. M. L.

1171. *Vapour Pressure of Ternary Mixtures.* **F. A. H. Schreinemakers.** (Zeitschr. Phys. Chem. 36. pp. 257–289, Feb. 22; 413–449, March 12; 710–740, April 19; 37. pp. 129–156, May 17; and 38. pp. 227–255, Aug. 23, 1901. Also Archives Néerlandaises, 5. pp. 214–226, 1900.)—A theoretical discussion of the various cases that may occur in the study of the vapour pressure of ternary mixtures. [See also Abstract No. 345 (1902).] T. M. L.

1172. *Constitution of Binary Alloys.* **J. A. Mathews.** (Frank. Inst., Journ. 153. pp. 1–22, Jan.; 119–140, Feb.; Discussion, pp. 221–230, March, 1902.)—This paper contains a valuable summary of recent researches, the subjects considered being the crystalline structure and effects of strain in pure metals; freezing-points of metals; alloys as solutions; molecular freedom in solids; solidification phenomena in binary alloys, cooling- and freezing-point curves; the nature of eutectics; solid solutions, alloys, and the phase-rule. G. W. de T.

STEAM PLANT, GAS AND OIL ENGINES.

1173. *Steam Turbine Trials.* **C. A. Parsons** and **G. G. Stoney.** (Inst. Mech. Engin., Proc. 4. pp. 797–812; Discussion, pp. 813–816, Sept., 1901. Paper read before the Glasgow Engineering Congress (Section III.), 1901.)—This paper contains a number of valuable tables giving the results of trials with turbo-dynamos. The author points out that the steam consumption closely follows a straight-line law, and that the fact that internal lubrication is not required obviates most of the difficulties encountered in the use of superheated steam for reciprocating engines, besides enabling the exhaust steam to be returned to the boilers direct without oil filters. The most interesting tests were those made at the works, of one of two 1,000-kw. turbo-alternators built for the city of Elberfeld, and constructed to give 1,250 kw. at 4,000 volts and 50 ∿, the alternators being four-pole, running at 1,500 r.p.m., and directly coupled to the turbines. The accompanying very instructive table is based on the results. The calculated figures in column 12 will enable comparison to be made with the steam consumption of reciprocating engines, working with saturated steam. Tests made to determine the advantages of superheating and the effect of varying the vacuum showed a gain of about 12° per cent. with 55° C. superheat, and that every inch of vacuum improves the consumption about 4 per cent.

Discussion.—**Schröter** stated that the trials made at Elberfeld six months after erection, the report of which would be published, gave even better results than the Newcastle trials, owing to slightly greater superheating, and that a comparison was made with a Sulzer engine driving a 1,000-kw. Brown-Boveri alternator in the same engine-house. The most noteworthy difference was that the steam consumption of the turbines, other things being equal, decreased constantly with increasing loads, whereas the piston-engine showed the highest consumption with maximum load. This was obviously due to the thermal pressure of the expanding steam being, in the case of the turbine, always equal to the condenser pressure, while the throttling increased with decreasing load; while, in the case of the piston-engine, the increased cut-off with increasing load increased the difference between the terminal steam pressure and that of the condensers. The turbo-alternators ran well in parallel, both with each other and with ordinary piston-engines. **W. Ripper** advocated high superheating (350° F. was employed in all the Schmidt type of engines), to which turbines were so specially adapted. He did not think sufficient emphasis had been given to the equality between the terminal steam pressure and that of the condenser. It was to utilise the work wasted in the case of piston-engines through the difference between these pressures, that the SO_2 engine tried at Charlottenburg had been devised. **G. G. Stoney** stated that tests made on turbines after long use showed no decrease in economy. With reference to superheat, no tests had been made at degrees higher than 100° F. which gave an economy of 12 per cent. With 350° F. this would probably reach 20 per cent. He stated that turbo-alternators were running successfully in parallel with every sort of engine at various stations. At Elberfeld the turbines were running sixteen times as fast as the Sulzer engines.

Load.	Average observed Steam Pressure. Absolute.	Corresponding Temperature of Saturated Steam.	Average observed Temperature of Superheated Steam at Inlet Valve.	Superheating. (Col. 4—Col. 3).	Observed Steam Consumption per kilowatt-hour.	Total heat contained in 1 kilogramme of steam at observed steam pressure.		Measured Consumption of Heat per kilowatt-hour (Col. 8 × Col. 6).	Corresponding Consumption of Saturated Steam per kilowatt-hour (Col. 9 ÷ Col. 7).	Corresponding Consumption of Steam at 11 kg. absolute and at 14·3° superheating (1 kg. of steam = 669·2 cal.).	Corresponding Consumption of Saturated Steam at 11 atms. absolute (1 kg. of steam = 662·3 cal.).
						In Saturated condition.	In Superheated condition.				
(1) Kilowatts.	(2) Kg. per cm.²	(3) C.°	(4) C.°	(5) C.°	(6) Kg.	(7) Calories.	(8) Calories.	(9) Calories.	(10) Kg.	(11) Kg.	(12) Kg.
1190·1	10·11	179·3	189·5	10·2	8·81	661·1	666·0	5,867	8·87	8·76	8·86
994·8	10·47	180·9	192·0	11·1	9·14	661·7	667·0	6,096	9·21	9·11	9·20
745·3	10·76	182·0	190·0	8·0	10·12	662·0	665·8	6,738	10·18	10·07	10·17
498·7	10·40	180·6	209·7	29·1	11·42	661·6	675·6	7,715	11·66	11·53	11·66
246·5	10·14	179·4	196·4	17·0	15·31	661·2	669·4	10,248	15·50	15·31	15·47
No load with excitation.	10·34	180·3	193·0	13·3	per hour. 1844	661·5	667·8	per hour. 1,231,423	per hour. 1861	per hour. 1840	per hour. 1859
No load without excitation.	10·49	181·0	194·5	13·5	1183	661·7	668·2	790,481	1194	1181	1194

G. W. DE T.

1174. *Water-tube Boilers. Report on Trials of H.M.S. "Hyacinth" and "Minerva," and R.M.S. "Saxonia."* (Engineering, 73. pp. 278–282, Feb. 28., and pp. 326–331, March 7, 1902.)—This is a reprint of the Report issued by the Admiralty Committee on Water-tube Boilers, which embraces progressive trials of engines and boilers at 2,000, 5,000, 8,000 h.p. and full power; and also full particulars of the trial runs to Gibraltar and back, which were previously noticed [see Abstract No. 2234 (1901)]. Voluminous details are given in tables and diagrams for which the original Blue Book must be consulted. The general effect of these trials is to show that the Belleville boilers of the *Hyacinth* are not so good as the Scotch boilers of the *Minerva* or *Saxonia*, except as regards thermal efficiency and the evaporation per lb. of coal from and at 212° F., in which the Belleville results were higher than the *Minerva's* but lower than the *Saxonia's*. The beneficial influence of retarders in the boilers of the *Minerva* was distinctly marked. F. J. R.

1175. *The Morrin "Climax" Steam Boiler.* (Engineering, 73. pp. 342–343, March 14, 1902.)—This boiler consists of a vertical cylindrical water-drum of steel, placed centrally in the boiler casing, with a large number of small water-tube loops extending radially round the entire circumference of the central drum, but placed at an angle so that one end of each loop pierces the drum at a higher point than its other end. These radial loops occupy all the space inside the casing from a short distance above the fire to nearly the top of the drum, which also projects downwards below the grate-bars. The fire-grate is annular in form and there are four firing doors, placed at equal intervals round the casing. The feed-water is heated in a special coil before it enters the boiler, and the steam is superheated by means of a series of diaphragms in the upper part of the drum which cause the steam to pass through the upper tiers of loops which are above the water-level. The steam then passes back into the upper part of the drum from which it is taken. The diaphragms also hinder priming. A report by Bryan Donkin on the performance of the boiler accompanies the article, which is illustrated.
F. J. R.

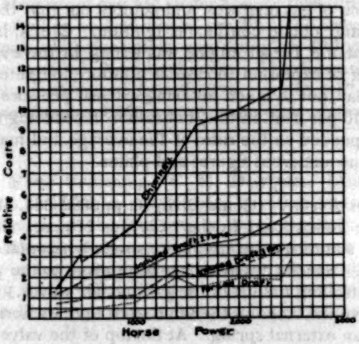
1176. *Feed-water Heaters in Condensing Plants.* **C. G. Robbins.** (Power, N.Y. 22. pp. 13–15, Feb., 1902.)—This paper contains a table of degrees of difference for various initial and final temperatures of water, and also a table of the number of square feet of heating surface required to raise 1,000 lbs. of water from various initial to various final temperatures, both on the basis of a steam supply of 126° and 141° F. in vacuum heaters and of 212° F. in atmospheric heaters. These tables and some examples are worked out from the data given by J. E. Lewis and H. L. Hepburn [see Abstracts Nos. 758 and 759 (1902)].
F. J. R.

1177. *Mechanical Scale Remover for Boilers.* (Eng. and Mining Journ. 73. p. 250, Feb. 15, 1902.)—The Dean steam tube cleaner consists of a small cylinder for steam or compressed air, which has an oscillating piston inside to which a hammer is attached working outside, one end of the cylinder like the clapper of a bell. The vibrations of the hammer are very rapid and light. For water-tube boilers the hammer is formed as a chipper. Boilers must be dry when the machine is used. F. J. R.

1178. *The "Airedale" Feed-water Heater.* (Elect. Rev. 50. pp. 512–513, March 28, 1902.)—This is a heater of the vertical tube type, the peculiarity of its design consisting in the use of a spiral retarder or deflector in the interior of the tubes through which the steam passes downwards whilst the water surrounding the tubes outside flows upwards in the casing. This aids the transfer of heat so much that the time required to heat the water from 70° and 200° F. has been reduced from 28¼ minutes with the same tubes without deflectors to 5 minutes with deflectors. F. J. R.

1179. *Recent Progress in the Construction of Superheaters.* **M. Miet.** (Génie Civil, 40. pp. 232–235, Feb. 1, 1902.)—This article refers generally to the advantages of superheating, and notices the principal forms in use [see Abstract No. 2231 (1901)] adding a short description of the most recent French forms. These are a modern form of the Uhler, the Badére, Maiche, Piat, and Roser apparatus. The use of the thermo-electric pyrometer of Le Chatélier for regulating and controlling the temperature to which the tubes are exposed is discussed and the author concludes that the temperature of the heating gases rather than that of the steam should be observed. F. J. R.

1180. *Advantages of Mechanical Draught.* **H. F. Schmidt.** (Amer. Electn. 14. pp. 63–65, Feb., 1902.)—After enumerating the advantages, as regards the conditions of combustion and its completeness, of mechanically produced forced draught over induced draught, in which class chimney draught is included, the author investigates by means of figures the comparative efficiencies of the two systems. A chimney 180 ft. high, 10 ft. in diameter, an atmospheric temperature of 62° F., and escaping gases at 500° F., are taken as the elements of the investigation. The pressure produced by that chimney would be 6·25 lbs. per sq. ft. of area, and the corresponding height of a column of air 82·1 ft., which, as a head, would cause a velocity of 72·71 ft. per second. From these data the useful and the total work done are computed, and on working out the same results for a fan having an efficiency of 0·5, with an engine consuming 50 lbs. of steam at 150 lbs. per sq. in. per h.p.-hour, and a boiler efficiency of 80 per cent., the fan is shown to be 71·3 times as efficient as the chimney. For a boiler plant consisting of 14 water-tube boilers, 2 economisers, and proper fittings, the costs belonging to chimney draught are $13,100, as against $6,300 for mechanical draught plant complete.



The above set of curves was prepared by W. B. Snow, from nine plants with forced, induced, duplex induced, and chimney draught, and shows clearly the comparative costs of the various systems.

The author also works out the economy resulting from the use of a mixture of cheap coals, which could not be profitably used with chimney draught unless by a chimney of prohibitive dimensions and cost. F. J. R.

1181. *Automatic Feed Regulation of Steam Vehicle Boilers.* **J. E. Baldwin.** (Horseless Age, 9. p. 289, March 5, 1902.)—The author gives a *résumé* of the methods and principles at present employed in automatic feed-water regulators. C. R. D'E.

GAS AND OIL ENGINES.

1182. *Gas Engines.* **D. Clerk.** (Inst. Engin. and Shipbuilders, Trans. 45. pp. 1–43, Feb., 1902.)—The author reviews the history of the development of gas engines, and discusses the principles which have determined their increase in efficiency to the value of 30 per cent. now attainable. He describes various types of oil and petrol engines, and the large engines working with blast-furnace gases. Finally, he mentions his own experimental work and the various engines built on the Clerk cycle, with an impulse every revolution; a large number of engines are now being built to use this cycle. He believes that further developments will be on the lines of an impulse per revolution and of compounding. For marine work he thinks a constant-pressure flame engine would be required.

Discussion.—**Foulis** believed that explosion engines in large units would become too unwieldy, and looked to constant-pressure flame engines for further development. He described some experiments made by him on continuous ignition of gas mixtures, and pointed out that the difficulty was to avoid explosion and obtain continuous ignition. **Clerk**, in reply to several speakers, said that the Diesel engine was wrong in theory, and pointed out the serious danger of explosion in case of a failure to ignite. The advantage of compounding lay, not so much in saving exhaust pressure, as the maximum saving would be 10 per cent. in this, but rather in reducing the weight of the engine, which depended on the ratio of the average and maximum pressures. The paper contains numerous figures and plates. G. H. B.

1183. *Niel Gas Engine.* (Génie Civil, 40. pp. 362–363, March 29, 1902.)—A new gas engine constructed by the "Cie des Moteurs Niel" is described. It is intended for stationary use, and has a single horizontal cylinder working on the Otto cycle. Special attention has been given to the governing, which is effected by controlling the lift of the gas and air valves. These valves are mounted one above the other on the same stem, and are normally held against their seatings by an external spring. At the top of the valve stem is mounted the piston of an air dashpot; the ingress of air into the dashpot as its piston descends, with the valve stem, on the admission stroke of the engine, being regulated by a centrifugal governor. The valves are controlled from the admission cam on the cam-shaft by means of a telescopic rod coupled to a bell crank, one end of which is forked, and engages with a collar on the valve stem. A spring in the telescopic rod holds the roller at its lower end against the cam, and presses the bell crank fork against the valve stem collar in opposition to the tendency of the valve spring to hold the valves on their seats. The normal action of the admission cam is to compress the telescopic rod spring and cause it to overcome the valve spring so lifting the valves, but if the governor comes into operation more or less vacuum is created in the dashpot as the piston on the valve stem descends, and the lift of the valves decreases as the combined pressure of the valve spring and pressure on the dashpot piston become more nearly equal to the downward pressure of the telescopic rod tending to open the valves. The following gas consumption figures are given :—

Running light	9·64	cubic metres per h.p.-hour.
Half charge, 25·26 h.p.	15·147	„ „
Full „ 46·02 „	20·194	„ „

The thermal efficiency works out at 18·8 per cent. on half and 25·5 per cent. on full charge, and the mechanical efficiency at 86 per cent. The normal speed is 216–219 r.p.m. C. R. D'E.

1184. *Bardon's Portable Combined Oil Engine and Dynamo.* (France Automobile, 7. pp. 186–187, March 22, 1902.)—In this article a detailed description is given of the conditions which have to be fulfilled by a combination of oil engine and dynamo, so as to be effective, economical, and at the same time portable. In the case described a 12-h.p. four-cylinder vertical engine is coupled direct to a dynamo, and both are fixed on to the same framework. Electrical ignition is employed. The oiling is done automatically. The dynamo used was a four-polar one, and capable of generating 50 amperes at 145 volts pressure and at 980 r.p.m. On trials made with that combination for 10 hours and 45 minutes the results obtained were: Current generated 42 amperes, voltage 149; 5, at a speed of 960 r.p.m., the power generated was 67, 2 kw.-hours, and the total oil consumed was 64 litres. This gives a consumption of 0·951 litres of oil per kw. generated, or 0·56 litres per h.p. Considering the price of oil to be 0·40 francs per litre, the expenditure per h.p. comes to 0·225 francs. The sizes made vary from 8 to 12 h.p., and the motors are accordingly made with 1, 2, or 4 cylinders. The dimensions of the combination used in the trial were: Length, 2 m.; width, 0·67 m.; and height, 1 m. The total weight was 1,000 kg. A side view of the combination is given. L. G.

1185. *Gasoline Motor Governing.* **C. E. Duryea.** (Automobile Rev. 6. pp. 27–28, Feb., 1902.)—This is usually effected by either completely or partially preventing the ejection of the exhaust, or by completely suppressing the admission. The author advocates governing by operating a throttle valve in the admission pipe in such a manner as to weaken the impulses without completely suppressing them. Cars fitted with motors controlled by a throttle valve can be driven like steam cars on one gear if a large engine is employed. C. R. D'E.

1186. *The Alcohol Motor.* **E. Neubery.** (Automotor Journal, 6. pp. 194–196, Feb., 1902.)—Gives the results of experiments made at the Technical High School of Berlin on a 4-h.p. alcohol engine by Körting Bros. coupled to a dynamo. The principal results are arranged in Table I., the experiments being divided into five groups :—

1. The series from 1 to 8 were for the purpose of determining the efficiency of the motor, alcohol of 92·5 per cent. being employed as fuel.

2. 9 to 12 show the effect produced by admixture of benzol and benzene. (They also serve as carburetting material.)

TABLE I.

No.	Percentage composition of the fuel.				Mean diagram pressure.	Temperature of the exhaust gases in degrees centigrade.	Indicated horse-power in i.h.p.	Effective horse-power in e.h.p.	Price per i.h.p. in Pfennigs.[1]	Price per e.h.p. in pfennigs.	Thermal efficiency, per cent.	Mechanical efficiency, per cent.	Total efficiency, per cent.	Converted into work, per cent.	Lost in cooling water, per cent.	Carried off in the exhaust gases, per cent.	Due to combustion to CO.	Remainder in per cent.
	Alcohol.	Water.	Benzol.	Benzene.														
1	92·50	7·50	—	—	2·97	349	2·90	1·462	13·10	25·92	17·73	50·5	8·98	17·73	35·75	18·81	1·108	26·602
2	92·50	7.50	—	—	3·22	370	3·12	1·620	12·27	23·53	18·95	51·9	9·87	18·95	32·70	20·72	0	27·63
3	92·50	7·50	—	—	3·88	345	3.56	2·646	11·08	14·90	21·00	74·3	15·63	21·00	33·49	18·10	0	27·41
4	92·50	7·50	—	—	3·86	356	3·79	2·960	11·08	14·13	21·00	78·1	16·42	21·00	36·47	21·81	1·012	29·808
5	92·50	7·50	—	—	5·68	323	4·28	3·566	11·21	13·39	20·85	83·2	17·35	20·85	38·84	16·76	1·388	22·162
6	92·50	7·50	—	—	4·85	338	4·40	3·788	10·26	11·89	22·70	86·2	19·55	22·70	34·10	15·51	1·069	26·621
7	92·50	7·50	—	—	5·74	308	4·72	4·278	10·15	11·15	22·90	90·9	20·80	22·90	33·67	10·45	0·912	32·068
8	92·50	7·50	—	—	5·82	324·99	5·05	4·076	10·05	12·45	23·10	80·6	18·65	23·10	44·15	15·01	1·117	16·623
9	84·075	6·825	9·1	—	5·22	341	4·82	4·047	10·08	12·00	21·85	84·4	18·34	21·85	40·14	13·36	0	24·65
10	77·1	6·25	16·65	—	5·38	337·5	4·68	4·037	9·18	10·62	22·90	86·1	19·72	22·90	39·90	12·07	0·0306	25·1094
11	85·075	6·825	—	9·1	5·38	321·5	4·43	3·606	9·12	11·12	26·17	81·3	21·24	26·17	43·33	16·08	1·090	13·330
12	77·1	6·25	—	16·65	5·66	339·5	4·99	4·006	11·15	13·72	21·79	80·2	17·72	21·79	43·41	12·68	0	22·12
13	67·50	32·50	—	—	2·72	346·5	2·38	1·265	18·85	34·50	12·35	53·2	6·75	12·35	26·02	11·20	1·145	49·285
14	78·66	21·34	—	—	3·49	356	3·50	2·274	12·10	18·42	19·39	65·0	12·60	19·39	33·07	16·83	0	30·71
15	87·188	12·812	—	—	4·81	338	4·44	3·564	10·03	12·80	22·60	80·4	18·17	22·60	36·17	18·77	0·0351	22·4249
16	77·802	22·198	—	—	5·32	324	4·62	3·414	10·03	13·95	22·49	73·9	16·67	22·49	32·79	17·80	0	26·92
17	79·344	20·656	—	—	5·78	346	5·23	4·263	10·01	12·48	22·98	81·3	18·64	22·98	38·19	13·97	1·095	23·765
18	60·57	39·43	—	—	6·54	321	5·38	3·146	9·25	15·76	25·19	58·5	14·74	25·19	26·67	9·35	0	32·79
19	92·50	7·50	—	—	5·34	308	4·92	3·840	9·51	12·40	24·56	78·1	18·74	24·56	35·10	10·5	0·292	29·548
20	92·50	7·50	—	—	3·255	321	3·72	1·718	11·12	24·17	20·93	46·2	9·67	20·93	31·23	15·15	0·331	32·359

[1] 8 pfennigs are equal to one penny.

3. The series 13 to 18 show the influence of different amounts of water mixed with the alcohol.

4. The series 19 and 20 shows the effect of the governor, which was not employed in experiments 1 to 18.

5. Experiments in which it was attempted to use pure benzol or pure benzene were not successful.

The mean values of the efficiencies work out as follows: Thermic efficiency, 21·215 per cent.; mechanical efficiency, 71·1 per cent.; total efficiency, 16·325 per cent. The cost of the alcohol and of other small motors per h.p.-hour is given in Table II.

TABLE II.

Kind of Engine.	Per H.P.-hour.					
	Deprecia-tion.	Interest.	Attend-ance.	Oil.	Fuel.	Total.
Gas motor	3·34	1·335	1·04	0·9	8·53	15·145
Petroleum motor	3·34	1·335	1·04	0·9	8·25	14·865
Alcohol motor	3·34	1·335	1·04	0·9	15·35	21·965
Benzene motor	3·34	1·335	1·04	0·9	14·2	20·815
Acetylene motor	4·03	1·61	4·16	0·9	23	33·70
Electric motor	1·39	0·556	—	0·2	14·6	16·746

C. R. D'E

1187. *Letombe Motor.* (Écl. Électr. 30. pp. 173–174, Feb. 1, 1902.)—This is a vertical petrol motor having two cylinders of unequal bore, the small cylinder above the large, and on the same centre-line. A double piston, forming a single casting, enters the two cylinders, the smaller piston projecting up through the combustion chamber of the large cylinder, and leaving an annular ring of somewhat larger area than itself exposed to the pressure in the large cylinder. Each cylinder has its inlet and exhaust valves and ignition plug, so that they may be worked independently or together. The piston casting is coupled to the crank-shaft by a single connecting rod. Using both cylinders a working stroke is obtained at every revolution. A throttle valve is fitted in each induction pipe, which enables the relative proportions of pure and of carburetted air to be suitably regulated; beyond the point where the rotation of the throttle cuts off the carburetted air and admits pure air only, a further rotation causes a finger to hold open the inlet valve. The electric ignition for both cylinders is effected by a single induction coil and a high-tension rotary switch. C. R. D'E.

1188. *Fritscher Houdry Motor.* **L. Fournier.** (Locomotion Automobile, 9. pp. 102–104, Feb. 13, 1902.)—This is a four-cycle alcohol motor for stationary work, with a single horizontal cylinder 85 mm. bore × 160 mm. The carburettor is of the float-feed spraying type, and is mounted in close proximity to the exhaust box, both the air inlet pipe and the admission pipe to the engine being heated by the exhaust gases. A hit-and-miss governor is arranged to act on the admission valve. Between the mechanically operated admission valve and the cylinder is an automatic spring-controlled valve, the object of which is to prevent blowing back, the mechanical valve being so arranged that the internal pressure tends to force it open. The engine weighs 250 kg., and developes 1·27 b.h.p. at about 430 r.p.m. C. R. D'E.

1189. *Aster Governor.* (Horseless Age, 9. p. 266, Feb. 26, 1902.)—This is a compact form of centrifugal governor, actuating a throttle valve in the inlet pipe of a petrol motor. The throttle valve is of the piston type, and of considerable bore relative to the inlet pipe so that a comparatively short movement of the piston suffices for full opening or closing of the passage from carburettor to engine. C. R. D'E.

1190. *Fan Radiators.* (Locomotion Automobile, 9. pp. 119–121, Feb. 20, 1902.)—Several forms of radiators for cooling the jacket water on motor cars propelled by internal combustion engines are described. They are designed by J. Gronville and H. Arquembourg, and consist of spiral water-pipes having exterior radiating flanges, enclosed in a cylindrical case behind which is a fan driven from the engine. A continuous stream of air through the radiator is thus ensured at whatever speed the vehicle is travelling. C. R. D'E.

1191. *Kingston Carburettor.* (Automobile Rev. 6. p. 35, Feb., 1902.)—This carburettor is of the float-feed type, the float controlling a ball valve at the petrol inlet aperture. The carburettor jet opens into a box in which are interspaced discs of wire gauze. The air enters at the bottom of this chamber below the jet, and the top is connected to the induction pipe of the engine. C. R. D'E.

1192. *Favron Carburettor.* **P. Sarrey.** (Locomotion Automobile, 9. p. 121, Feb. 20, 1902.)—A small chamber, which is situated in a casting extending across the carburettor box, has three ports, one connected to the petrol supply, one to the jet, and one to a pump which is operated by the deflection of a diaphragm under the influence of the slight vacuum formed in the carburettor box on the suction stroke of the engine piston. The petrol inlet and the jet are normally closed by spring-controlled cone valves. The pump and central chamber having been filled on a suction stroke of the pump, the succeeding stroke forces the liquid out of the jet, the violent pulverisation assisting the carburation of the indrawn air. C. R. D'E.

1193. *Non-Freezing Liquids for Cylinder Jacket.* **E. E. Keller.** (Automobile Rev. 6. pp. 28–29, Feb., 1902.)—The properties of solutions of calcium chloride ($CaCl_2$) and of glycerine in water are discussed, and curves given showing the freezing- and boiling-points of solutions of varying strength. A solution of $CaCl_2$ of sp. gr. 1·2 freezes at about —15° F. and boils about 220° F. A solution of glycerine of sp. gr. 1·1 freezes about 0° F. and boils about 220° F. $CaCl_2$ is a cheap commercial article, and has practically no action on steel, iron, copper or brass, but acts upon galvanised iron and zinc to an appreciable extent. C. R. D'E.

AUTOMOBILISM.[1]

1194. *Steam Motor Cars for Railway Service.* (Eng. News, 47. pp. 102–105, Feb. 6, 1902.)—The advantages attaching to the employment of steam motor cars on branch lines where ordinarily a 500–800 h.p. locomotive is used for conveying, say, about twenty or so passengers is beyond all question, as under the latter circumstances traffic must be carried on at a dead loss. The steam motor has advantages not possessed by the storage battery, which has for such service been tried and found wanting, and, besides its many faults, is expensive both to establish and maintain. Its radius of action is also very small, cars so equipped being practically closely tethered to the power stations; which same objection applies also to the compressed-air motor and the different kinds of stored steam or superheated-water motors. The trolley and conduit systems have troubles of their own when concerned with the operation of long lines with light traffic, particularly in connection with the heavy cost of road and central station with capacity sufficient to take care of the maximum traffic. The internal combustion motor is at present unsuitable on the score of difficulties met with in starting. Several experimental steam cars have from time to time been tested in America without leading to any results beyond showing the enormous field which a successful steam car would open for cheap railway lines. The failure of the cars tested was due to the motor being designed too much on the lines of ordinary locomotive construction: to the cars having too much dead weight: to being designed for too high a speed and with too great a hauling capacity. Steam motor construction will be successfully developed by copying electric car construction and utilising speed-reducing gears placed between the engines and driving axle, while the employment of oil fuel may obviate the existing difficulties in connection with firing. The boiler design is a most cogent factor, and either a miniature Scotch boiler or a water-tube variety would probably meet the case.

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[1] Electric Automobiles are described in the Section dealing with Electric Traction.

The first car dealt with was constructed by the Schenectady Co. An old 60-ft. dining-car was taken, and one of the six-wheel trucks removed. This end was then altered for receiving the engine or "steam truck," the interior of the car being partitioned off for an engine-room. The vertical boiler (top 5 ft. 8 in., bottom 4 ft. 4 in.) was rigidly attached to the trunk or engine frame so that no flexible steam-pipes were required. It was fitted with a Regan water-grate. The storage of water gave rise to trouble, for this being gradually consumed during the trip, it was necessary to arrange the springs so that the car could ride easily with a variation of load of about 12,000 lbs. From running tests it was found, however, that no ordinary application of truck springs would give an easy riding body with the great load variation. The Erie R.R. had a similar car built, the rear end of the car being carried, in this case, by an ordinary four-wheel passenger car truck. Its use was discontinued because of the jar transmitted from the engine to the passenger end of the car and of the insufficiency of the boiler capacity. The Baldwin steam car—built for the Cincinnati, Hamilton, and Dayton Railway—had its boiler stationary in relation to the car body, resting upon the framing of the car, flexible connections being employed. The gear was arranged in the usual way, the special feature being the vertical boiler with a circular firebox tube and conical smokebox. Circular rows of 1¼ tubes were fitted between the plates, whilst a 10-in. tube passed through the centre, being connected at the top with a coal magazine surrounding the smoke-stack. Around the tube's base were twelve circulating tubes projecting down into the firebox and guiding the coal to the centre of the grate. This car was withdrawn from service after a few months, the automatic stoking not being a success, whilst the tubes became overheated and the boiler capacity was generally insufficient. Unpleasant vibrations and swaying of the car was caused by the tanks and condensers. Oil fuel was experimented with by way of increasing the steam capacity, but the want of room in the firebox of these vertical boilers precluded any chance of success. The Baldwin Car Company also built the steam motor used by the Pittsburg, Cincinnati, Chicago, and St. Louis Railway, with an engine of the Vauclain four-cylinder compound type, valve gear of the Stephenson shifting link pattern, and a vertical boiler of the submerged flue type with a coal magazine round the smoke-stack. Boiler trouble again upset all calculations, the self-feeding arrangements not working properly. The Rowan steam car, extensively employed, has the engine and car portion separated, with an arrangement by which the front ends of the car sills would be supported on the engine frame. In this car the forward end is hinged and can be thrown open to clear the boiler. The steam "dummy" system is still in use on minor street and suburban U.S. railways, but speed is necessarily limited. C. E. A.

1195. *Loads on Horse Drawn and Motor Vehicles.* **E. R. Calthrop.** (Automotor Journal, 6. pp. 47–58, and pp. 61–63, Nov., 1901.)—Loads of 5, 7, and 10 tons are in ordinary use with horses. Five tons is the limit that can be carried on a motor waggon with a tare of 3 tons. But on a 3-ton motor waggon for which the existing English law prescribes a maximum width of 6 ft. 6 in., the available area of platform is 75 sq. ft. On the larger Liverpool horse-drawn lurries the platform surface (18 ft. 6 in. by 7 ft. 6 in.) amounts to 138 sq. ft. M. O'G.

1196. *Light Touring Cars.* **H. Ward Leonard.** (Horseless Age, 9. pp. 345–347, March 12, 1902. Lecture delivered before the Long Island Automobile Club, Feb. 26, 1902.)—The author goes carefully into points affecting the first cost, running and maintenance, &c., of a light motor carriage for pleasure purposes, comparing the merits of the three leading systems, viz., petrol, steam, and electric. He concludes by drawing up a table in which each type is judged with regard to safety, reliability, speed, depreciation, economy, hill-climbing, appearance, first cost, and noise and smell, and awards the petrol car the chief merit in the first five of these considerations, steam in the sixth and eighth, and electricity in the seventh and ninth. C. R. D'E.

1197. *White Steam Carriage.* (Horseless Age, 9. pp. 138–141, Jan. 29, 1902.) —This is a light vehicle for pleasure purposes, having seating accommodation for two persons. It has a tubular underframe, the front cross member of which holds the front wheel pivots, while the back cross tube encloses the live rear axle. The carriage body, together with engine, boiler, &c., are sprung from the underframe by four elliptic plate springs. The boiler is of the flash type, and consists of thirteen horizontal spirals, placed one above the other, of ½-in. metal tube, copper for the upper spirals, and steel for the lower ones next the furnace. The feed-water is supplied by a plunger pump worked direct off the engine, the feed being regulated by an automatic steam-pressure regulator. The feed-water enters at the centre of the top spiral, flows round this, then up and over this spiral and down into the second spiral, and so on, finally emerging as superheated steam from the external end of the bottom spiral, and thence passing to the engine under control of a throttle valve. The spirals constituting the boiler are interspersed with separating pieces and mounted in a cylindrical casing, at the bottom of which is the petrol vapour furnace. This consists of a flat cylindrical chamber closed top and bottom, and having numerous air-tubes passing through it vertically. Round the tops of the air-tubes are slits, through which the petrol vapour escapes from the interior of the chamber. The petrol in the supply tank is under air pressure. It passes through a vaporising coil before entering the

burner chamber, and the quantity of vapour passing is regulated by a thermostatic apparatus at the temperature of the steam in the boiler, and depending for its action on the difference in expansion of copper and iron. When the temperature exceeds a given value the petrol vapour is entirely cut off. An auxiliary burner for starting purposes is kept continuously alight, whether the main burner is on or off. Besides the automatic fuel regulator, a hand regulator worked from the driver's seat is fitted. The heating surface in the boiler is about 30 sq. ft. The average boiler pressure is about 200 lbs. per sq. in. The safety valve is set to 500 lbs. per sq. in. There is no gauge glass. The engine is of the simple two-cylinder vertical type, double-acting cylinders, 3 in. by 3 in., rated at 6 h.p. A link-reversing mechanism is fitted. Transmission to the live rear axle is by a single chain gear. Eight gallons of petrol and twenty gallons of water are carried. The total weight of the vehicle is 1,300 lbs. A photograph of the car and several diagrams are given.
C. R. D'E.

1198. *Hoffman Steam Carriage.* (Automobile Rev. 6. pp. 36–37, Feb., 1902.)—This is a light two-seated steamer, propelled by a two-cylinder vertical engine, of 6½ h.p., cylinders 3 in. bore by 4 in. stroke, which is geared to the live rear axle by a chain drive. The boiler is of the water-tube type, fired by a gasolene furnace. C. R. D'E.

1199. *Eclipse Automobile Co.'s Carriage.* (Automobile Rev. 6. p. 36, Feb., 1902.)—In this carriage the boiler and engine are mounted below the carriage seats, as is usual in American light steam cars. The boiler is of the water-tube type, 20 in. diameter × 18 in. high, and contains 200 ft. of steel tubing. It is fired from below by a gasolene furnace. The engine is a three-cylinder vertical one, with piston valves, and the power is transmitted to the live rear axle by enclosed bevel gearing. C. R. D'E.

1200. *Barrière Steam Car.* **F. Mirés.** (Locomotion Automobile, 9. pp. 150–153, March 6, 1902.)—The general lines of this car are practically identical with the Locomobile steam car [see Abstract No. 547 (1902)]. The boiler furnace, which burns petrol vapour, is, however, considerably modified. The petrol is vaporised in a small, separate furnace, so arranged that steam may be rapidly raised although the car has been standing for hours with main fire extinguished. C. R. D'E.

1201. *Gardner Serpollet Steam Car.* **L. Fournier.** (Locomotion Automobile, 9. pp. 182–186, March 20, 1902.)—Describes the latest type of Serpollet steam car. The mechanism does not differ in any essential feature from that of earlier types [see Abstracts Nos. 903 and 1732 (1900)]. Detailed drawings are given. C. R. D'E.

1202. *Knoxmobile.* (Automobile Rev. 6. pp. 37–38, Feb., 1902.)—In this vehicle the front and rear axle, are connected by two long side-plate springs with swivel ends, the carriage body being attached toward the centre of length of the springs. A single cylinder horizontal engine of 8 h.p. cylinder 5 in. bore × 7 in. stroke transmits through an epicyclic gearing giving two speeds forward and one reverse, and a single chain drive, to the exterior of the differential gear on the live rear axle. The engine is air-cooled, and may be started from the driver's seat. C. R. D'E.

1203. *Fischer Motor Vehicle.* (Automobile Rev. 6. pp. 41–42, Feb., 1902.)—A three-cylinder vertical gasolene engine of 10 h.p. at 600 r.p.m. is mounted at the front end of a channel steel underframe. Direct coupled to the crank-shaft is the armature of a 5-kw. 110-volt dynamo, which supplies current to two 5-h.p. motors which drive the rear road wheels independently by spur reduction gears. The excess power developed by the engine when the car is travelling slowly or downhill is stored in a battery of 50 cells of 90 ampere-hour capacity. The engine always runs at its most economical speed. An 18-passenger omnibus has been successfully constructed on this system. C. R. D'E.

1204. *De Dion Bouton Novelties.* (Automotor Journal, 6. pp. 182–187, Feb., 1902.)—This article includes descriptions of (*a*) a new light electric motor vehicle; (*b*) a small stationary petrol motor and dynamo plant; (*c*) the new 8-h.p. de Dion Bouton petrol carriage. (*a*) The underframe and running gear of this vehicle are almost identical with the standard type of petrol carriage, by this firm, except that the change-speed gear is dispensed with. The motor is mounted below the tubular underframe and in front of the differential gear box; it is of the four-pole type with drum armature; its normal speed is 800 r.p.m. The controller is arranged to give four speeds by series and parallel grouping of the field windings and the battery. The reverse is controlled by a separate switch; 44 de Dion Bouton cells of 200 ampere-hours' capacity are carried within the body of the vehicle. (*b*) This set consists of a 3-h.p. single-cylinder vertical engine coupled direct to a Manchester type dynamo, designed to give 20 amperes at 110 volts at 1,300 r.p.m. Regularity of running is secured by the use of an electrically controlled throttle governor on the engine. (*c*) This vehicle has a tubular underframe sprung from the front axle by longitudinal, semi-elliptic, plate springs, and from the back axle by one transverse and two longitudinal springs; this latter spring being attached to the centre of the back cross tube of the frame. The motor is mounted at the front of the underframe; it has a single vertical cylinder, water-cooled, electric ignition, and governing by reducing the left of the exhaust valve; the flywheel is external to the crank chamber. The change-speed gear is coupled to an extension of the crank-shaft by a jointed shaft. Two speeds forward and one reverse are obtained by an expanding clutch method of keying any one of the free spur wheels to its shaft. Motion is finally transmitted from the differential gear to the rear road wheels by jointed shafts similarly to the method employed on other vehicles by this firm. C. R. D'E.

1205. *Eastmead Biggs Car.* (Automotor Journal, 6. pp. 188–190, Feb., 1902.)—In this vehicle the engine and transmission gear are attached to a tubular underframe, which is connected with the front and rear axles in such a manner that the axles may be tilted relative to one another in vertical planes without straining the frame. The carriage body is sprung from the underframe by semi-elliptic plate springs. The engine is of the vertical, single-cylinder type, and is mounted at the front of the underframe. The transmission is by a direct extension of the crank-shaft to the change-speed gear, which is of the spur-wheel type with sliding pinions and expanding clutches, and finally by a worm gear to the exterior of the differential gear on the live rear axle. C. R. D'E.

1206. 15-*h.p. Mors Carriage.* (Horseless Age, 9. pp. 178–179, Feb. 5, 1902.)—The latest type Mors light car is illustrated and described. It has a four-cylinder, vertical engine and a four-speed forward and one reverse change-gear. As in previous types [see Abstract No. 1785 (1900)], the engine is mounted towards the front of the underframe, the power being transmitted through a cone clutch to the change-gear square shaft, by a bevel gear to the differential cross-shaft and by chains to the rear road wheels. Front and side elevation, and a plan of the arrangement of mechanism are given. C. R. D'E.

1207. *Eldin and Lagier Carriage.* **P. Sarrey.** (Locomotion Automobile, 9. pp. 87–92, Feb. 6, 1902.)—This car is constructed broadly on Panhard lines. The engine is of the Daimler type, water-cooled, governing on the exhaust valves, and fitted with both tube and electric ignition. It is constructed in several sizes with two or four cylinders. The engine is mounted on a sub-frame attached to the rectangular wooden frame, and has its crank-shaft lying on the longitudinal centre line of the frames ; the power is transmitted through a cone friction clutch to the change-speed gear, which gives four speeds forward and one reverse by spur wheels engaged by side contact. A bevil gear transmits from the upper spur wheel counter-shaft to the differential cross-shaft, and the power is finally transmitted to the rear road wheels by chain gears. Several illustrations of the mechanism are given. C. R. D'E.

1208. *"Darracq" Light Motor Car.* (Motorwagen, 5. pp. 60–63, Feb. 28, 1902.)—This article describes the 9-h.p. type of "Darracq" motor car, which is of similar construction to those dealt with in Abstracts Nos. 566 (1900) and 555 (1901). The motor, which is of the single-cylinder water-cooled type, is supplied with a mixture of petrol and benzene, and its output is regulated by varying the proportions of the mixture. The motor and its accessories, and the gear transmission are clearly illustrated. J. G.

1209. *"Protos" Motor Car.* (Motorwagen, 5. pp. 39–41, Feb. 15, and pp. 57–59, Feb. 28, 1902.)—The two articles describe the "Protos" light car manufactured by A. Sternberg. The motor and speed reducing and reversing gear are mounted upon a separate frame, suspended from the fore part of the main running frame of the car. The gear is driven through a longitudinal bevel gear shaft coupled to the motor shaft by means of a spring friction clutch coupling, and a chain transmission is employed between the speed and reversing gear and the live rear axle of the car. The gear is adapted for two forward and two reverse speeds of driving, the required changes being effected by means of clutches. A chain adjustment is provided at the rear part of the frame, and for this purpose the springs which support the rear axle are connected to the frame by links, to permit of movement of the axle in adjusting the chain tension. The car frame and mechanism are fully illustrated, and a table is given showing the number of teeth in the change wheels of the speed gear. J. G.

1210. *Decauville Light Car.* (France Automobile, 7. pp. 155–157, March 8, 1902.)—The new 10-h.p. Decauville car is described. It has a rectangular tubular underframe carrying the motor and change-speed gear towards its front end, and sprung by long semi-elliptic plate springs from the axles. The motor is of the double-cylinder, vertical type, with electric ignition and governing on the exhaust valves. The cylinders are 110 mm. bore × 110 mm. stroke, and the normal speed is 1,000 r.p.m. The power is transmitted through a cone clutch to the change-speed gear, which gives four speeds forward and one reverse, the highest forward speed being a direct drive without intermediary gearing. The lower half of the change-gear casing and of the crank chamber are formed in one casting, which also partially surrounds and protects the flywheel and clutch. The clutch is of the "Champion" type, with internal spring and working without end thrust when the power is on. The final transmission is effected by a jointed tail shaft and bevel drive to the exterior of the differential gearing on the live rear axle. The cooling water for the motor is circulated by a gear-driven centrifugal pump and cooled in a radiator mounted above the frame in front of the bonnet covering the motor. A complete plant, including dynamo, accumulators, and induction coils, is provided for the electric ignition. The motor is started on the cells, and at 600 revs. the dynamo is automatically brought into action, the current being divided between cells and induction coils. Above 1,000 revs., the cells are cut out so as to obviate overcharging. C. R. D'E.

1211. *Lepape Motor Vehicles.* **J. Caël.** (Locomotion Automobile, 9. pp. 166–168, March 13, 1902.)—The special feature in these vehicles is the motor, which has one working cylinder, water-cooled, and one cylinder acting only as a pump for sucking and compressing the explosive mixture. The cylinders are vertical and with pistons coupled to cranks at 120°. The pump cylinder sucks from the carburettor past an automatic inlet valve, and on the following up-stroke the charge is expelled past a second automatic valve into the working cylinder, the piston in which is then beginning to uncover exhaust ports in the cylinder wall towards the completion of a working stroke. The contents of the pump having been passed into the working cylinder, they are further compressed and exploded for the following down-stroke, there being one working stroke every revolution. C. R. D'E.

1212. *Vinet Light Car.* (France Automobile, 7. p. 166, March 15, 1902.)—In this car the underframe is of wood, reinforced with metal, the motor being mounted towards the front end. The transmission is by cone clutch to the change-speed gear, which gives three speeds forward and one reverse, with spur gears engaged by side contact. The power is transmitted from the change-gear countershaft to the differential cross-shaft by a bevel drive, and finally to the road wheels by chains. [See also Abstract No. 698 (1901).]
C. R. D'E.

1213. *Clement Carriage.* (Horseless Age, 9. pp. 365–369, March 19, 1902. From La Locomotion.)—In this car an 8-h.p. double cylinder engine is mounted towards the front of the underframe, the transmission being effected through a cone clutch to the change-speed gear, and thence by a jointed tail shaft to a bevel drive on the live rear axle. The engine is of the vertical type, with cylinders 3·4 in. bore × 4·4 in. stroke, and its normal speed is 1,100 r.p.m. A special feature is the method of retaining the piston-pin in place. This is effected by an additional piston-ring on the central plane of the pin, which is thus restrained from endwise movement. The engine cylinders draw their charge from a simple form of float-feed spray carburettor. The change-speed gear gives three speeds forward and one reverse by sliding spur gears. The weight of the car empty is 1,100 lbs. C. R. D'E.

1214. *Oil Engine Road-Rollers.* (Engineer, 93. pp. 296–297, March 21, 1902.)—Particulars are given relating to two road-rollers propelled by oil engines manufactured by the Dudbridge Ironworks, Limited, of Stroud, Gloucestershire, the rollers themselves being of French make. The actual rolling part of the machine does not differ essentially from the ordinary type, but an oil engine is substituted for the steam engine and boiler, the horizontal oil engine occupying much the same position as the boiler in a steam roller. The engine is rated at 16 h.p. and 180 r.p.m., and weighs about 70 cwt., the flywheel being 5 ft. 4 in. diameter by 7 in. wide. The consumption with any of the well-known brands of petroleum is stated to average 0·75 pint per b.h.p.-hour. The petroleum is vaporised in a carburettor heated by the ignition-tube burner. A compressed-air reservoir is provided for starting. Spur-gearing transmits the power to the rear road wheels, and a double-friction clutch is provided for forward and reverse motion of the machine. The rollers have been in successful operation for two years. C. R. D'E.

1215. *Acceleration of Automobiles.* **L. M. Aspinwall.** (Horseless Age, 9. pp. 320–321, March 12, 1902.)—The question of power required to accelerate motor vehicles is considered. In order to accelerate a vehicle at the rate of 1 mile per hour per second 4·55 lbs. effort at the rim of the driving wheels is required per 100 lbs. weight of vehicle. Curves are given which show the tractive effort which must be exerted per 100 lbs. weight to accelerate the same at from 0·25 to 2 miles per hour per second, and their application to the problem of finding the h.p. required to accelerate a vehicle of given weight to a given figure in miles per hour is explained. C. R. D'E.

1216. *Canda Motor Cycle.* **D. Bellet.** (Locomotion Automobile, 9. pp. 104–105, Feb. 13, 1902.)—This is a quadricycle of the well-known type, propelled by a single-cylinder, vertical petrol motor mounted behind the rear axle, and propelling this axle by means of a spur reduction gear. The article is illustrated by a diagram which shows clearly the relative positions and connections of engine, carburettor, and electric ignition apparatus. C. R. D'E.

1217. *Girardot Dirigible Balloon.* **L. Fournier.** (Locomotion Automobile, 9. pp. 134–136, Feb. 27, 1902.)—In this machine the load is lifted and supported by a cigar-shaped balloon, connected to which at either side in the longitudinal horizontal plane are æroplanes, the balloon being enclosed within and strengthened by the æroplane-supporting structure. At the centre of length of the balloon is a cylindrical chamber, below which is suspended a platform carrying the petrol motor which supplies the power for propelling the balloon. The two persons necessary for operating the machine are stationed in the central chamber, from which they have control over the several items of the mechanism. The power is conveyed from the motor to the propeller shaft by a belt drive. The propeller is situated at one end of the balloon, its shaft lying on the longitudinal centre line, and passing through a hollow stay which extends from end to end of the balloon. The machine is steered by operating two triangular sails at either side of the balloon.

C. R. D'E.

REFERENCES.

1218. *Structural Steel Details of Two-story Boiler-house.* (Eng. Record, 45. pp. 104–106, Feb. 1, 1902.)—This article contains sizes and details of the construction of columns and roof of the boiler-house erected by the United Railways and Electric Company of Baltimore. [See Abstract No. 416 (1902).] F. J. R.

1219. *Use of Balloons in War.* **E. H. S. Bruce.** (Soc. Arts, Journ. 50. pp. 277–283 ; Discussion, pp. 283–285, Feb. 21, 1902.)

GENERAL ELECTRICAL ENGINEERING.

1220. *Circuit-Breakers for High Pressure and Large Power.* **E. W. Rice, Jr.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 895–908, Dec., 1901.)—The author discusses the general considerations which should determine the design of large high-pressure electric power stations, with special reference to the switchboard arrangements, and the best form of circuit-breakers. At the recent experiments at Kalmazoo the circuit-breaker designed by the author for the Manhattan Railway Power Station [see Abstract No. 1372 (1900)] never failed to open 1,200- and 1,300-kw. circuits up to 40,000 volts, the highest pressure employed, without sign of fire or smoke, and quite noiselessly, and the author infers that they might be safely employed for much larger powers and pressures. Long break open-air switches are quite unsuitable, as even where sufficient room is available, they produce dangerously high resonance effects. At 40,000 volts, a circuit-breaker of this kind gave rise to an arc which held and flared to a length of over 30 ft., when it struck the line and short-circuited the system, producing at the same time high-voltage oscillations of two or three times the normal pressure. Another form of oil switch had evidently reached the limit of its capacity at 40,000 volts, flashing and, in some cases, smoking. Expulsion-tube air switches operated up to 25,000 volts, but failed at 40,000. G. W. DE T.

1221. *Automatic Cell Switch.* **P. Thieme.** (Elektrotechn. Zeitschr. 23. pp. 174–176, Feb. 27, 1902.)—The article describes an attachment applicable to an ordinary cell switch, consisting of a motor with worm gear actuated by a voltmeter relay, which closes the motor circuit for forward or backward motion, according as the pressure is too high or too low. G. H. B.

1222. *Kinsman Block System for Steam Railways.* (Elect. World and Engineer, 39. pp. 306–308, Feb. 15, 1902.)—This is a system by which the throttle valve of the locomotive is closed when a section of line ahead is blocked. At the entrance to each section are two "guard" or "contact" rails quite separate from the traffic rails, and slightly above the level of the latter, to which, however, they are secured by tie-plates, so that the relative difference in level is always the same. These "guard" rails are run over by two "contact" wheels mounted on the locomotion axle, but insulated therefrom. These wheels touch only the "guard" rails and avoid all cross-overs and frogs. Collectors press on the wheels to guide the current to an electromagnet on the engine. When such current passes, which is arranged to occur when a distant semaphore arm is to "danger," the magnet pulls up its armature and lets go a lever which works a valve. This movement operates to stop the steam supply and to apply the pneumatic brakes. The engineer has a lever within reach interlocked with this mechanism so that he can restore everything to its normal condition by throwing it forward, and this can be done so quickly that very little of the train's momentum need be lost. There is, however, no chance of his mistaking the character of the signal thus given. The ends of the "guard" rails are slightly bent downward to prevent injurious shock from the contact wheels. There is nothing movable on the roadbed to be clogged, broken, or displaced, and, owing to the formation of the contact wheels, the "guard" rail cannot become ineffective by reason of snow, ice, or other like obstruction. E. O. W.

1223. *Electrical Method of Determining the Velocity of Underground Water.* **C. S. Slichter.** (Eng. News, 47. p. 151, Feb. 20, 1902.)—A double row of 1¼-in. drive test wells are sunk across the channel of the river whose underflow is to be tested. The up-stream wells are charged with a strong electrolyte (ammonium chloride giving the best results). This dissolves, and passes down-stream with the moving water. The passage of the electrolyte towards the lower wells is shown by the gradual movement of the needle of a sensitive ammeter, and the final arrival at the well is shown by a sudden and strong deflection of the needle. If several of a row of wells are being used simultaneously, the main stream of the underground current will show itself by the rapidly rising electrical currents in certain of the wells. The electric circuit to the wells can be made in several ways. A brass rod, insulated from the well tube, and lowered into the down-stream well by means of a rubber-covered wire, may serve as one electrode, the casing of the same well constituting the other, the electrodes being connected by the ammeter and a battery. In this case, the indication of the movement of the ground water will not be noted until the electrolyte has reached the lower well, where its presence will be shown by a sharp rise in the current curve. Instead of this, the two wells themselves may be used as the electrodes, in which case the gradual passage of the electrolyte can be observed from the beginning, but the final indication of its arrival will be less pronounced. The best method is a combination of the two. The wire from the casing of the lower well is run to one pole of the battery through the ammeter; the other pole of the battery is connected to the internal electrode of the lower well through a resistance, and also to the casing of the upper well. The drive wells may be made of perforated sections from 4 ft. to 6 ft. long, so that a well will offer free passage to the water throughout its entire depth. E. C. R.

1224. *Electric Cranes at Middlesborough Docks.* (Electrician, 48. pp. 606–609, Feb. 7, and pp. 688–689, Feb. 21, 1902.)—Three 10-ton and seventeen 3-ton jib cranes have been erected, together with twenty-four 1-ton capstans. In the 3-ton cranes the height of jib top from the quay level is 60 ft., the radius of jib is 44 ft. 9 in., the speed of lifting 3 tons is 150 ft. per minute, speed of lifting 1½ tons is 250 ft. per minute, the revolving speed at the hook is 400 ft., and the travelling speed 80 ft. per minute. Details of construction are described in the first article. The controller is a combination of two controllers, which are actuated by one lever. One controller actuates the lifting motion and the other the slewing motion. The lever which controls them is so arranged that when moved in a vertical plane it actuates the lifting and in a horizontal plane the slewing controller. The capstans are capable of hauling loads of 100 tons along a level road. Upon the motor shaft there is fixed an automatic mechanical brake, which locks itself if the capstan tends to run backwards through being overloaded. Tests were made on the 3-ton cranes, and it was found that a complete cycle of operations required 0·17 unit of energy. The operations included lifting 3 tons through 30 ft., slewing through 120°, lowering 3 tons 30 ft., hoisting unloaded hook, slewing back through 120°, and lowering hook to ground. This cycle of operations can quite easily be performed forty-five times in an hour, and with a practised driver a still higher rate of speed is possible. W. H. S.

REFERENCES.

1225. *"Mars" Meter.* **J. A. Montpellier.** (Électricien, 23. pp. 49–51, Jan. 25, 1902.)—The "Mars" is a motor meter of the Thomson type, and presents no novel features except in details of construction. G. H. B.

1226. *Westinghouse Meter.* (Elect. Rev. 50. p. 267, Feb. 14, 1902.)—The meter is an alternate-current induction motor of the usual type. G. H. B.

1227. *Objects of Interest to Electrical Engineers in the Glasgow Exhibition of* 1901. **W. B. Sayers.** (Inst. Elect. Engin., Journ. 31. pp. 9–23, Dec., 1901.)—A description is given of the generating station and of numerous exhibits, including dynamos, motors, and transformers; gas, oil, and coal dust-engines; electrically driven machinery; telephone apparatus, &c. G. W. DE T.

1228. *Electrically-driven Tools.* (Engineer, 93. pp. 119–120, Jan. 31, 1902.)—A description, with photographs and some detailed drawings, of several portable, electrically driven machine tools (slotting, planing, and drilling machines) constructed by Messrs. Kendal and Gent, of Manchester. H. R. C.

1229. *Electric Locking of the Charles River Drawbridge.* (Railroad Gazette, 34. p. 89, Feb. 7, 1902.)—A very brief description with several diagrams, showing the way in which the movement and locking of the bridge are electrically controlled by the signalman. The work was carried out by the Union Switch and Signal Company of America. [See also Abstract No. 733 (1900).] W. H. S.

1230. *Wellman Furnace-charger.* (Génie Civil, 40. pp. 257–260, Feb. 15, 1902.)—The article describes an apparatus which is used for charging Siemens-Martin furnaces, and is operated electrically. W. H. S.

1231. *"Ricks" Accumulator.* **A. Ricks.** (Centralblatt Accumulatoren, 3. pp. 29–31, Feb. 1, 1902.)—The article contains some general particulars regarding this cell and curves of discharge with electrodes of various thicknesses. E. J. W.

GENERATORS, MOTORS, AND TRANSFORMERS.

1232. *Standardising Electrical Machinery.* **G. Kapp.** (Inst. Mech. Engin., Proc. 4, pp. 825–840; Discussion, pp. 841–845, Sept., 1901. Paper read before the Glasgow Engineering Congress (Section III.) 1901.)—In this paper the author deals with the standards for rating and testing electrical machinery provisionally adopted by the German Association of Electrical Engineers in June, 1901, a complete translation of the regulations being given as an appendix to the paper. They deal with generators, motors, rotary converters, motor generators, and static transformers. For rating purposes a division is made into three classes, according to the time during which they are to be used, viz., (*a*) intermittent use; (*b*) short-time use; (*c*) continuous use. Class (*a*) includes motors for cranes, hoists, traction, &c.; class (*b*) those in which the period of work is shorter than necessary to reach the final temperature, and the period of rest is long enough to permit the temperature to fall approximately to that of the air. The rated power is to be that which can be given off (*a*) for one hour without exceeding the temperature limits; (*b*) for a number of hours stated in a plate attached to the machine; (*c*) continuously. In the latter case the temperature rise is measured after a ten hours' run in the case of moving machinery, and whenever it has reached a stationary value in the case of transformers. The temperature limits, in ordinary cases, and if the air-temperature does not exceed 35°; of insulated conductors, commutators, and slip-rings, are, for cotton-covered wire 50°, for paper-covered wire 60°, and for wires insulated with mica, asbestos, &c., 80°, an additional 20° being allowed in each case for tramway motors. With regard to overload, it is pointed out that this should only occur for a short time, and under such temperature conditions that the permissible temperature rise is not exceeded, and, with this limitation, it is provided that generators, motors, and converters must be capable of an overload of 25 per cent. for half an hour, on the condition that, in the case of alternators, the power factor should not be lower than that marked on the plate; while motors, converters, and transformers must be capable of an overload of 40 per cent. during three minutes, on the condition that, for motors, the normal terminal pressure is to be maintained. The measurement of insulation resistance is not prescribed, but a breakdown test at high voltage, and this has been designedly kept within reasonable limits, since a breakdown test at very high voltage may, even if the machine stands it, cause permanent injury.

The most difficult task of the committee was the framing of rules for testing efficiency, and this has been met by giving eight methods, and leaving to the maker the right of selecting the one to be used, which is to be specified in his tender.

In the course of the discussion, **P. E. Huber** observed that his experience indicated that a test of eight to ten hours was not always conclusive for machines having to stand continuous work under full load (*e.g.*, for electro-chemical purposes), perhaps for months. Such machinessome times showed their defects only after two or three days' continuous working. The **Author,** in the course of his reply, referred to the important point raised by Huber as one that might be reconsidered. A ten hours' test might or might not be enough for big machines, depending on their construction. G. W. DE T.

1233. *Calculation of Field Rheostats.* **R. Krause.** (Elektrotechn. Zeitschr. 23. pp. 66–68, Jan. 23, 1902.)—The author developes a simple method of calculating the number of steps and the value of the resistance corresponding to each step in a field rheostat, so as to enable the p.d. to be kept within certain limits as the load is steadily increased. The experimental data assumed by the author are the magnetisation curve of the machine and the value of the exciting current corresponding to full load at the normal p.d. A. H.

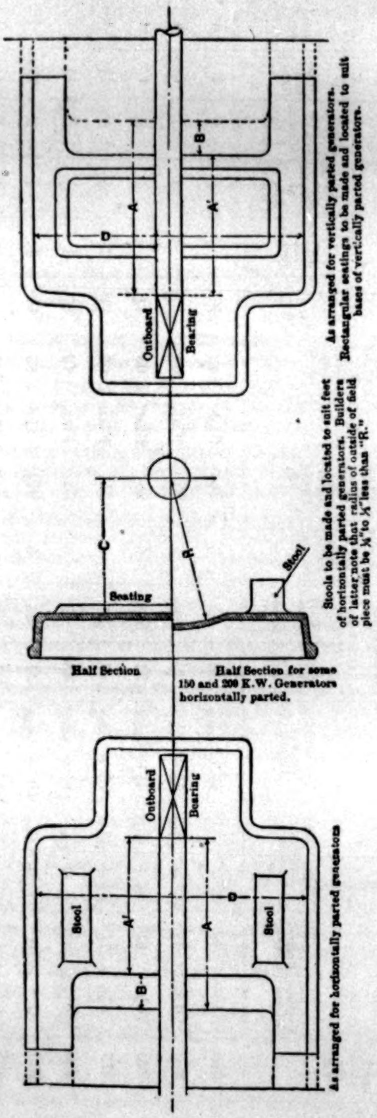
1234. *Standardising Direct-connected Continuous-current Units.* (Amer. Soc. Mech. Engin., Trans. 23. No. 916, pp. 99–108; Discussion, pp. 108–110, Dec., 1901. Also Elect. Rev., Jan. 24 and 31, 1902.)—The report deals only with units up to 200-kw. capacity, and the endeavour has been to reduce the number of standard units as far as possible. The diameters of shafts have been decided by the permissible deflection, and it is to be noted that the recommendations apply only to engines of the usual proportions, with the dynamo attached at the side of, and not between, the cranks. Owing to the marked difference in generator shaft-length adopted by different makers for the same power, generators are divided into "long" and "short," having a maximum difference of 6 in. in length of shaft, as shown in the accompanying table. To reduce the cost of patterns for the different lengths of sub-base, a standard pattern is proposed, with a standard adjustable end for each unit. The dimensions chosen for the height of the axis of the shaft above the top of the sub-base are sufficient to allow for vertically-split machines, and also, except in the case of the two largest units, to clear the periphery of horizontally-split machines. This allows of the use of one main pattern, to which patterns for the stool, or the rectangular seatings, required for the two classes of machines respectively, can be attached, as shown in the accompanying illustration, before the pattern is sent to the foundry. In the case of the 150 and 200 kw. units, a recess is to be provided in the top of the sub-base to allow the lower part of some horizontally split frames to be accommodated, and thus avoid unduly raising the shaft. In the case of those which do not need it, including all vertically-split machines, the top of the sub-base will be flat and continuous. *Armature fit.*—The allowance for a pressed fit is fixed at $\frac{1}{1000}$ in. for 4-in. to 6-in. shafts, and $\frac{2}{1000}$ in. for 6½ in. to 11 in., and is to be by increased shaft diameter. It is recommended that the dynamo maker should furnish the engine builder with a gauge the exact diameter of the bore. *Overload Capacity.*—It is recommended that the standard overload rating should not exceed 25 per cent. of the rated capacity, and some engine builders suggest calling attention to the importance of special attention when the unit is so operated. Various other minor suggestions are made. Straight keys are recommended, to be used as feathers, their lengths being left optional. *Discussion.*—**W. A. Drysdale** observed that in installing over eighty plants within the last few years his practice had exactly agreed with the table, except that he used larger shafts, to allow for defects in forging. With regard to overloads his practice had been to require an excess above the normal rating of 25 per cent., and an overload of 50 per cent. for a few minutes. He then described an "Armature Jack" successfully used in all his work for placing the armature on, and removing it from, the shaft.

TABLE OF SIZES, SPEEDS, AND STANDARDISED DIMENSIONS OF DIRECT-CONNECTED GENERATING SETS.

Capacity of Unit, Kilowatts.	Revolutions per Minute.	ARMATURE BORE.		DIAMETER OF ENGINE SHAFT AT ARMATURE FIT.		SPACE OCCUPIED ON SHAFT BETWEEN THE LIMIT LINES.		*B*, Length of Extension Pieces, Inches.	*C*, Height of Axis of Shaft above Top of Base, Inches.	*R*, Inches.	*D*, Width of Top of Sub-Base, Inches.	KEY (A FEATHER).				HOLDING-DOWN BOLTS.	
		Centre Crank Engines, Inches.	Side Crank Engines, Inches.	Centre Crank Engines, Inches.	Side Crank Engines, Inches.	Long Class *A*, Inches.	Short Class *A′*, Inches.					Width, Inches.	Thickness, Inches.	Depth in Shaft at Edge, Inches.	Projection above Shaft at Edge, Inches.	Diameter, Inches.	Number.
25	310	4	$4\frac{1}{2}$	$4 + \frac{1}{1000}$	$4\frac{1}{2} + \frac{1}{1000}$	30	25	5	$23\frac{1}{2}$	Flat.	48	1	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	1	4
35	300	4	$5\frac{1}{2}$	$4 + \frac{1}{1000}$	$5\frac{1}{2} + \frac{1}{1000}$	33	28	5	25	Flat.	54	1	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	1	4
50	290	$4\frac{1}{2}$	$6\frac{1}{2}$	$4\frac{1}{2} + \frac{1}{1000}$	$6\frac{1}{2} + \frac{2}{1000}$	37	31	6	28	Flat.	60	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	1	4
75	275	$5\frac{1}{2}$	$7\frac{1}{2}$	$5\frac{1}{2} + \frac{1}{1000}$	$7\frac{1}{2} + \frac{2}{1000}$	43	37	6	31	Flat.	66	$1\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{4}$	4
100	260	6	$8\frac{1}{2}$	$6 + \frac{1}{1000}$	$8\frac{1}{2} + \frac{2}{1000}$	48	42	6	34	Flat.	72	$1\frac{1}{2}$	1	$\frac{1}{2}$	$\frac{1}{2}$	$1\frac{1}{4}$	4
150	225	7	10	$7 + \frac{2}{1000}$	$10 + \frac{2}{1000}$	51	45	6	$37\frac{3}{4}$	$41\frac{1}{4}$	84	$1\frac{3}{4}$	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	$1\frac{1}{4}$	4
200	200	8	11	$8 + \frac{2}{1000}$	$11 + \frac{2}{1000}$	54	48	6	$42\frac{3}{4}$	$47\frac{1}{2}$	96	2	$1\frac{1}{4}$	$\frac{5}{8}$	$\frac{5}{8}$	$1\frac{1}{2}$	4

NOTE 1.—Five per cent. variation of speed permissible above and below speeds in table.

NOTE 2.—Distance from centre of shaft to top of base of outboard bearing may be less than *C* (to suit engine builder), though not less than possible outside radius of armature.


As arranged for vertically parted generators.
Rectangular seatings to be made and located to suit bases of vertically parted generators.
A
A'
B
D
Outboard Bearing
C
R
Seating
Stool
Half Section
Half Section for some 150 and 200 K.W. Generators horizontally parted.
Stools to be made and located to suit feet of horizontally parted generators. Builders of latter note that radius of outside of field piece must be ¼" to ⅛" less than "R."
Outboard Bearing
Stool
A'
A
D
B
Stool
As arranged for horizontally parted generators

G. W. de T.

1235. *Self-Exciting Alternator.* **M. Latour.** (Ind. Élect. 11. pp. 77–78, Feb. 25, 1902.)—The author has devised a generator closely resembling the one described by Heyland [see Abstract No. 2475 (1901)]. Imagine a stator consisting of a laminated hollow core provided with a low-resistance star-connected three-phase winding. This forms the armature of the generator. Inside the stator is placed the rotor, which carries the inducing or field-winding. The core of the rotor may be either *solid* or laminated, and its winding would consist of a continuous-current armature winding, provided with a commutator and brushes placed in suitable positions. If three-phase currents be fed into the rotor through the brushes, they will give rise to a rotating magnetic field, the angular velocity of which depends on the frequency of the current and the number of poles. The angular velocity of this field *in space* will obviously be quite independent of the angular velocity of the rotor. By driving the latter at the speed of synchronism in a direction corresponding to that of the field, relative displacement of field and rotor is prevented, the rotor winding loses its counter-e.m.f., and behaves like a non-inductive resistance. If the field is connected direct across the generator terminals, its resistance must be sufficiently high to stand the full p.d. without excessive heating; the winding would, therefore, be a high-resistance winding, precisely analogous to the field-winding of a continuous-current shunt-wound machine. Since the field-winding is practically short-circuited by the armature winding, it forms a very effective damping coil, and prevents hunting. The author next considers the action of such a shunt-wound alternator when used as a motor. It may be made to run synchronously at all loads by a proper adjustment of the brushes for each load. A. H.

1236. *Alternators in Parallel.* **della Riccia.** (Écl. Électr. 30. pp. 418–419, March 22, 1902.)—The different causes which effect the angular velocity of the rotor of an alternator are enumerated. The angular velocity (ω) of the rotor is given in the form $\omega = \Omega\,(1 + \frac{1}{\delta}\sin k\Omega t)$, where Ω is the mean angular velocity, k the time of a complete revolution of the rotor divided by the periodic time of the variations of the turning forces acting on it; and $1/\delta$ is the "irregularity," so that $1/\delta = (\omega_{max} - \omega_{min})/2\,\Omega$. Hence if θ be the geometric lag at any instant between any radius of the rotor and the position it would have had if its velocity were Ω, then $\theta = \int(\omega - \Omega)\,dt = -1/\delta k\,.\cos k\Omega t$. If the alternator have $2\,p$ poles, the lag of the actual vector of the e.m.f. behind the mean vector (a) will be given by $t - p/\delta k\,.\cos k\Omega t$. The problem of two similar machines working in parallel is then discussed, and algebraical solutions are obtained for the e.m.f.'s of the two alternators, their cross-currents, &c. It is proved that in order to prevent the irregularity of one of the alternators being greater than when it is running alone, the flywheel inertia must be increased by a certain amount, a formula for which is given. A. R.

1237. *Tests of Heyland's Compensated Induction Motor.* **A. Heyland.** (Elektrotechn. Zeitschr. 23. pp. 28–30, Jan. 9, 1902. Also Electrician, Jan. 24, 1902.)—The author gives an account of some preliminary experiments carried out by the Vereinigte Elektricitäts-A.-G., with a single-phase induction motor constructed as recently described by the author [see Abstract No. 2475 (1901)]. The experimental motor used in these tests was in reality a three-phase, 12-h.p., 6-pole, 300-volt, 50-cycle motor. Two of its phases were left connected in series, and were supplied with a single-phase current, while the third phase was disconnected, and a portion of it used for supplying the exciting current to the rotor through two diametrically opposite brushes. The rotor was provided with a continuous-current wave winding connected to a commutator whose segments were bridged by non-inductive, low-resistance strips. In using the machine as a single-phase motor, the brushes were first adjusted to correspond to the highest power-factor, and then the number of turns (of the third phase) used for supplying the exciting current was varied until a power-factor of unity was obtained, the final adjustment being obtained by slightly displacing the brushes. When used as an ordinary single-phase motor, this machine had a power-factor of 0·75 at full load, and a no-load current of 15 amperes. By using the compensating device, the power-factor could be made equal to unity, and the no-load current reduced to 3 amperes. The machine was next run as a self-exciting generator. At first it refused to retain its excitation, but on increasing the speed beyond a certain limit it could be switched off from the source of supply, and would then go on running, supplying its own exciting current. When loaded, it had a drop of voltage from no-load to ¼ load amounting to 2 per cent. The author suggests that a small hand-machine might be used for giving such a compensated generator the first impulse required to start its excitation.

A. H.

1238. *Testing Motor Losses.* **W. E. Sumpner.** (Inst. Elect. Engin., Journ. 31. pp. 632–641 ; Discussion, pp. 641–645, March, 1902.)—The magnitudes of the frictional and other losses in motors and dynamos are deduced by Swinburne's method from the way a running machine slows down. In the first way described the only apparatus required is an ordinary watch, a good speed indicator, and some means of applying to the machine a small measured retarding torque. The approximate equation $T = T_0 t'/(t - t')$ is proved, where T is the retarding torque due to losses in the machine, T_0 is a known mechanical torque, t is the time the machine takes to slow down from R_1 r.p.m. to R_2 r.p.m. when T is the torque and t' is the time the machine takes to slow down from R_1 to R_2 when $T + T_0$ is the torque. Now by varying the excitation we can measure by the same means a new value of T, and so separate the torque due to hysteresis and eddy currents from the torque due to friction. The torque may also be applied electrically by Hay's method [see Abstract No. 2493 (1900)]. If W be the watts wasted due to machine losses, and w be the watts generated in the machine during the test, then, as before, $W = wt'/(t - t')$. It is pointed out that for alternators running in parallel the synchronising apparatus can be employed to measure the speed by means of the method of beats. The speed can also be determined in many cases by using a low-pressure voltmeter to measure the difference between the volts of the field-magnet coils and the induced e.m.f. in the armature. The results of tests by this method of a Parker dynamo belted to a Tangye gas engine are given. In the discussion, **Henry Lea** said that he thought that the losses when the dynamo is driving the engine with constant effort would be very different to the losses when the engine is driving the dynamo at full load. In his reply, the **Author** stated that he had aimed at raising a discussion on the most suitable means of testing machines with simple instruments and without the necessity of troublesome preliminary arrangements. The methods described were best adapted to test large machines.

A. R.

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1239. *Capacity in Transmission Lines.* **G. Sartori.** (Elettricista, Rome, 11. pp. 41–44, Feb., 1902.)—The author shows that the capacity of a wire at a given distance from the earth is twice that which would be due to another wire at twice the distance. He works out numerically the case of an overhead transmission line of three wires, showing that, neglecting the effect of the earth, and considering only the effects of the wires on one another may lead to an error of over 50 per cent. A. E. L.

1240. *Plant Erection at the Manhattan Railway Power Station.* (Street Rly. Journ. 19. pp. 74–84, Feb., 1902.)—The article describes, with numerous illustrations, the various steps in the assembling of one of the units, consisting of a Reynolds' engine direct-coupled to a revolving field Westinghouse generator, these being of interest on account of the unusual size of the units [see Abstract No. 977 (1901)]. Before placing the shaft in its bearings, the generator hub and cranks were forced on by a portable hydraulic press with a capacity of 500 tons pressure. The weight of the flywheel generator field (370,000 lbs.) causes a deflection in the shaft, which had to be allowed for by making the axes of the low-pressure cylinders approach each other by 7/32 in. at the top. The requisite inclination of the cast-iron columns on which the cylinders rest was obtained by means of a 30-in. spirit-level, furnished with a graduated glass upon which was marked the necessary deflection, calculated from the weight of the field and the rigidity of the shaft, and which amounted to 0·0095 in. in 30 in., the length of the level. The hub of the field, which is of cast steel, was placed in position on the shaft before attaching the peripheral castings or web plates which take the place of spokes. In building up the field, the main rim, to which the laminated field poles were to be attached, were placed in position and held by temporary spokes before the side webs were put on. There are four of these sections, and they were built up around the spokes, with the wheel in a stationary position, and keyed together. After the rim had been bolted and keyed together, it was trued upon the inside by a gauge-rod placed between the hub and the rim. The temporary spokes were provided with turnbuckles, consisting of long nuts with fine right- and left-hand threads, by means of which the field was accurately centred. The web plates are made in sections, and the first few put on were staggered on each side of the rim around the field. These held the rim in position while the temporary spokes were removed. At the centre of the web, strengthening plates were riveted to the sections before they were erected. The remaining connections in the construction of the wheel are made with heavy bolts, which pass through holes reamed out after the plates were in position. At the sides of the hub, outside of the web plates, are placed two large strengthening rings. The hub contains ridges which engage in corresponding recesses in the inside parts of the web, to diminish the strain on the bolts when running, and give increased rigidity.

G. W. de T.

1241. *Wrexham Central Station run with Refuse.* (Electrical Times, 21. p. 51, Jan. 9, 1902.)—W. Sillery, the Borough engineer, reports that during December, 1901, the whole of the steam required for the station was obtained from the Meldrum four-cell refuse destructor, with the exception of Sundays and the Christmas holidays, when there was no collection of refuse. A table showing the maximum load, units generated, and hours of running for each day in the month are given. The units of electric energy generated per ton of refuse burnt are stated to average 37·8. G. W. DE T.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1242. *City of London Electric Lighting Company's Continuous-current Plant.* (Electrician, 48. pp. 723–730, Feb. 28, 1902.)—This paper gives a description of the extensions made in 1899 and 1900. These include three 1,000-kw. and two 2,000-kw. machines. The 1,000-kw. machines are Allis-Westinghouse combinations, the engines being of the vertical cross-compound condensing type, with 28-in. and 60-in. cylinders and 48-in. stroke running at 90 r.p.m. The 2,000-kw. machines are Musgrave-Westinghouse combinations, with 38½-in. and 76-in. cylinders and 54-in. stroke, running at 75 r.p.m. An important feature of this generator is the employment of the Westinghouse system of compensated armature winding, wherein certain points of the armature windings, which should be at equal potentials, are connected together by additional conductors, so that if there is any difference of potential between these points, on account of want of magnetic balance, there will be a flow of current through the corresponding conductors in one direction or the other. These currents interact on the field magnets either demagnetising or magnetising them to produce the necessary state of balance. Full details are given of the construction of these dynamos. The surface-condensers are of the Edwards type, constructed by Messrs. de Ritter and also by Messrs. Musgrave. An illustrated description of a special form of automatic exhaust relief valve is given. This value is partly counterbalanced by an external weight connected thereto by a flexible wire rope which passes into the exhaust pipe through a pipe having a gland and stuffing box at its outer end. The valve, when open, rests against a central shield which deflects backward pulsations of steam and thus prevents chattering. The generators supply three-wire 2 × 202 volt networks. Balancing is done at substations on the network by Parker balancing transformers, and also at the station by an ordinary Parker open hand-regulated balancer running at 620 r.p.m. The fuses are designed by O. L. Peard, and consist of a plaster-of-Paris base having a spring slide of the same material pressed outwards against the fuse-strip; at this point, the fuse-strip is thinned and protrudes through the plaster-of-Paris cover. The middle wire of all networks is earthed at the generating station, this earth connection being attached to the lead coverings of the various feeding and distributing cables which are placed in separate wrought-iron pipes. The paper is illustrated by a number of drawings and photographs. C. K. F.

1243. *South London Electricity Works.* (Elect. Rev. 50. pp. 223–227, Feb. 7, 1902.)—The works are owned by the South London Electric Supply Corporation, and serve the parish of Lambeth. The Company agreed to destroy the refuse of the parish for 11½d. per ton. The district is 6 miles long, and varies in width from ½ mile to 2 miles, and is, in parts, of a scattered nature. The high-pressure single-phase alternating-current system is used, and the generating plant consists of five coupled sets, four of which have Ferranti engines and "copper" type alternators. The latter work at 3,000 volts, 50 cycles per second, and the outputs are: one, 1,000-kw. at 160 r.p.m., one 1,200-kw., and two 300-kw., each at 350 r.p.m. The exciters are driven by ropes from the engines. The fifth set consists of a Yates & Thom engine, coupled to a British Thomson-Houston alternator, giving 500 kw. at 250 r.p.m., and is provided with an automatic expansion governor acting on the high-pressure cylinder only. Eight Babcock & Wilcox double-drum boilers, each capable of evaporating 10,000 lbs. of water per hour, form the steam-raising plant, and deliver superheated steam at 200 lbs. per sq. in. Mechanical stokers were at first used, but discontinued owing to smoke nuisance. The refuse destructor (temporarily disused owing to litigation) consists of sixteen cells arranged one on each side of a boiler, and are charged by means of special trucks, the arrangements being very similar to the Shoreditch plant. The steam-piping is on the ring main system, with a cross connection in the centre, and the flanges are of the spigot and socket type. The feed-piping is in duplicate throughout. The feed-pumps are driven partly by steam and partly by electric motors, the latter being double-wound and operated on the series-parallel method. Surface condensing plant is installed in a subway under the engine-room, capable of dealing with 28,000 lbs. of steam per hour, and the circulating water is cooled in a creosoted wood tower. The switchboard provides for running the plant in two groups, or all in parallel. No difficulty is experienced in paralleling, notwithstanding the different wave forms and other characteristics of the alternators. The 3,000-volt switches are of the single oil-break type. An illuminated indicator board, visible from all the stop valves, and operated from a keyboard by the switchboard attendant, is used to convey instructions to the drivers. Six feeders supply independent high-pressure networks, which feed independent low-pressure networks through transformers in street boxes. The high-pressure feeders are laid in earthenware ducts, and the low-pressure mains on the solid systems. All the cables are paper-insulated, lead-covered. A time switch is used to switch the street arc lamps in and out at the proper times. F. B.

1244. *Electric Lighting and Power at the Philadelphia Mint.* **C. W. Pike.** (Elect. World and Engineer, 39. pp. 201–205, Feb. 1, 1902.)—This is a large isolated plant installation of a very complete nature. The steam-raising plant consists of eight Babcock & Wilcox 150-h.p. boilers, designed for a pressure of 150 lbs. per sq. in., arranged in two sets of four boilers each. For artistic reasons, the buildings being of considerable architectural beauty, the use of a high chimney-stack was undesirable, and forced draught is therefore employed, produced by a 96-in. Sturtevant fan. This is capable of being driven by either of the two engines fixed at the ends of the shaft. The steam-piping, of which a plan is given, is made up of three systems, in duplicate—high, medium, and low pressure. The medium pressure, obtained by means of reducing valves, is used on the auxiliaries, and the low pressure is used for heating. The power plant consists of four direct-connected slow-speed units. The engines are by the E. P. Allis Co., and the dynamos by the Crocker-Wheeler Co. The sizes and speeds are: one 100-h.p. set at 150 r.p.m., for the night load, one 200-h.p. set at 135 r.p.m., and two of 300-h.p. at 100 r.p.m. The steam consumptions per i.h.p. per hour are 21·5 lbs. for the largest, and 23 lbs. for the smallest engine. Long air-gaps are provided in the generators, so that inaccuracy in centring, or wear in the bearings, has but a small effect on the magnetic balance. The voltage is 250. Individual motor-driving is used for almost every purpose, the installation including up to the present 121 motors, ranging from ⅛th-h.p. to 50-h.p., and aggregating over 750-h.p. There are four 8-h.p. topping machines (for cutting off the rough ends of the ingots), six 50-h.p. ingot rolling machines, six 25-h.p. finishing rolling machines, nine ½-h.p. "strip" annealing furnace travellers, nine ¼-h.p. rotary furnace travellers, twelve 7½-h.p. coining presses, and twelve of 8-h.p., twelve 8-h.p. cutting presses, ten ⅛-h.p. automatic weighing machines, and ten 8-h.p. up-setting machines (for raising the edge). The presses, of course, vary in size, according to the denomination of the coin. The average speed of coining is 85 pieces per minute, and the total pressure required for the large coins is 170 tons. Photographs show the method of driving the various machines. Eight elevators are employed, having motors varying in size from 30 to 50 h.p. The switchboard and wiring system are described. The lighting installation comprises 4,000 incandescent and 16 arc lamps. The telephone and fire-alarm systems are also described; the former is on the exchange system and serves 51 instruments. Thirty alarm boxes are distributed throughout the building, and the turning of the handle of any one automatically records its number five times on the ink-writing register, and simultaneously two gongs strike the number. Diagrams of storage battery connection, and plans of engine-room and switchboards are given. F. B.

1245. *Bristol Electricity Works.* (Electrician, 48. pp. 643–648, Feb. 14, 1902.)—The old station contains plant of 3,150 kw., of which all but 450 kw. is alternating, and is fully loaded; owing to lack of space, extensions cannot be made, so a new station has been laid down at Avonbank. The lighting load is to be gradually transferred to the new works, and the old station will be used for power supply only. The foundations of the new building consist of concrete piers, owing to the marshy subsoil. Coal is conveyed from barges on the Feeder River to bunkers at the top of the boiler-house by a gravity railway and Hunt bucket conveyor. There are four Babcock-Wilcox boilers at present, with superheaters and Meldrum stokers. Induced draught is used, the steel chimney being only 70 ft. high; the fan is driven by a Chandler steam engine, automatically controlled by the boiler pressure. There will be three Siemens copper-type alternators, of 745 kw. each at normal load, driven by Willans 3-crank engines; two Siemens dynamos, of 165 kw. each, with Willans 2-crank engines, have been installed to provide power to drive the motors, &c., on the works. Allen surface condensers and Doulton water softeners have been provided. The switchboards are of the Ferranti type. The alternators are paralleled through an impedance coil, as at the old station. The latter is fed from the new works through three 0·3 sq. in. trunk mains, of Siemens concentric paper-insulated and lead-covered type. There are 55 substations. A. H. A.

1246. *Partick Municipal Electricity and Destructor Works.* (Electrician, 48. pp. 892–896, March 28, 1902.)—The *boiler-room* contains four boilers each with 2,010 sq. ft. heating surface and 39 ft. grate area. Three of the boilers have two "destructor cells," each capable of consuming 10 tons each of refuse per diem. The complete destructor and boiler plant with fans, economiser, &c., is supplied by Manlove, Alliott & Co. The feed-water is heated by the exhaust steam from the main engines, fan engines, and pumping engines. The water is from the Glasgow Corporation mains. The *engine-*

room contains two 150-kw. and two 75-kw. Bellis-Peebles steam dynamos. The engines by Messrs. Bellis Morecomb run at 500 r.p.m. The larger units are triple expansion and the smaller units compound. The cylinders have piston slide valves. Each engine drives direct a four-pole shunt-wound dynamo by Messrs. D. Bruce Peebles & Co., generating at a pressure of 480 to 520 volts. The balancer consists of two 15-kw. machines coupled together and the booster of two 15-kw. dynamos on the same shaft as a 30-kw. motor. *Feeders* of triple concentric and lead-covered type from the British Insulated Wire Co. are drawn into Doulton conduits and are of sections varying between 0·3 and 0·06 sq. in. They terminate in feeder pillars in place of ordinary manholes. Each pillar is made for one feeder and six distributors. Total length of feeders is 6 miles. Distributors of the same make as the feeders are laid for about 8 miles, besides 4 miles of arc cables. The station is equipped with a double battery of 284 Tudor L.B. 11 type accumulators capable of discharging at 75 amperes for eight hours, or 180 amperes for three hours. The equivalent of 7,000 8-c.p. lamps has been applied for.

J. L. F. V.

1247. *Berkshire Street Railway Company, Mass.* (Street Rly. Rev. 11. pp. 65–69, Feb., 1902.)—This line, which is 50 miles long, receives power from a station at Pittsfield. Three-phase current is generated at 13,800 volts; at this pressure it is sent along a transmission line, and converted at substations to 380 volts for use in connection with rotary converters, which supply direct current at 600 volts. The insulators for the high-tension line are of glass, and have petticoats 7½ in. in diameter. W. H. S.

1248. *The Aurora Elgin and Chicago Railway.* (Street Rly. Journ. 19. pp. 107–110, Feb., 1902.)—This railway is being constructed to take 40-ton cars running at a scheduled speed of 40 miles per hour, including stops, with the stations 3 miles apart, and a maximum speed of 65 miles an hour, on the General Electric multiple unit system. Each car will have four 125-h.p. General Electric motors, the motor equipment being designed to give a maximum speed of 70 miles an hour on the level. The construction is being carried out with "a solidity which savours strongly of English steam railroad construction." The track rails weigh 80 lbs. per yard, and are in 60-ft. lengths. A third rail of T form, weighing 100 lbs. per yard, is to be used, except on a small portion which does not run over a private right-of-way. The conductivity will be sufficient to enable copper continuous-current feeders to be dispensed with. The power is to be transmitted at 26,000 volts over three-phase lines supplying converter stations which will feed the third rail directly, and will not be normally sectioned, but all tied together. These 26,000-volt feed-lines will be of aluminium, and so arranged as to give a duplicate feed to the greater part of the road. A telephone-despatching system is to be used, and the substation attendants will receive messages from the despatchers, and deliver them to the train crews. G. W. DE T.

1249. *Hartford and Springfield Electric Tramway.* (Street Rly. Journ. 19. pp. 90–94, Feb., 1902.)—The power-house, brick-built with steel roof trusses, is nearly in the centre of the line, on the banks of the Connecticut River, and has a brick chimney 130 ft. high with a core 6 ft. in diameter extending nearly to the top. The boiler-house is 51 ft. 8 in. by 49 ft. 5 in., and the engine-room 105 ft. by 91 ft., the floor being 12 ft. above the basement, which contains the steam-piping, air-pumps, condensers, &c. Exhaust steam from each engine is carried directly into an American feed-water heater, and then into a Knowles twin vertical air-pump and condenser through the usual valves. Drips and condensed water from the steam mains, &c., are collected in a Holly receiver, and returned directly to the boilers, and another pump and receiver return the condensations from the car-house and office-heating systems, which are supplied from the power-house. There are two batteries of water-tube boilers by the Aultman Taylor Company, having a rated capacity of 750 h.p., with space for the addition of 500 h.p. In the boiler-room are two duplex double-plunger Deane boiler-feed pumps, each capable of running the entire plant. An auxiliary feed-water heater, placed near the pumps, receives the exhaust steam from the feed-pumps, air-pumps, and receiver. The steam main is carried on adjustable roller brackets, and long-turn steel bends connect it to the boilers and engines by short runs and heavy by-passed O.S.Y. valves. The fire exhaust is carried to the roof and topped with an exhaust head. The water passes usually through all the heaters, but the numerous long-turn bends and valves are so arranged that any or all of the heaters can be cut out if necessary. The lagging consists of 85 per cent. magnesia. The station at present contains two cross-compound engines by the Wetherell Engine Company, each direct-connected to 300-kw., 500-volt, continuous-current General Electric generators controlled by a Standard General Electric switchboard. Space is left for a third unit. The track is laid throughout with 70-lb. steel rail, A.S.C.E. standard section in 30-ft. lengths, with Weber joints, and 8-in. stranded concealed bonds. The feeder wire is 500,000 circular mils throughout, and No. 00 trolley with Craighead flexible brackets is employed. G. W. DE T.

1250. *St. Paul and Minneapolis Interurban Railway.* (Street Rly. Journ. 19. pp. 159–170, March, 1902.)—This paper deals mainly with the causes which have made such a great financial success of this line. Great stress is laid on the high character of the track construction. Of the 251 miles of track, 76 miles have cast-welded joints. Twenty-five miles on paved streets have 80-lb. T-rails, 7 in. high, laid without ties, with a concrete beam 15 in. wide by 8½ in. deep under each rail. The track is held to gauge by tie-rods 10 ft. apart. The flange-way for the wheels is made with granite block toothing in asphalt streets, and brick in brick-paved streets. In unpaved streets the standard construction is an 80-lb. T-rail, A.S.C.E. standard, as used on steam roads. Most of the rest of the track consists of 56-lb. and 60-lb. rail. The power supply from the St. Anthony Falls water-power plant [see Abstract No. 2508 (1900)] has had to be supplemented by the aid of the old steam plant to supply the peaks of the load. This plant is not capable of being worked under economical conditions, and the increase in traffic has now made it inadequate. A three-phase steam plant, generating at 3,450 volts, is therefore being erected alongside the water-power plant, which can be operated in parallel with the latter, allowing the water-wheels to run with a constant full load, and making the steam engines do the greater part of the regulation. A 3,500-kw. three-phase General Electric generator is to be used, direct-connected to a vertical Reynolds-Corliss engine by the Allis-Chalmers Company. It is of the revolving field flywheel type, and the specifications require that it should operate for twenty-four hours at the rated load with not more than 30° C. rise above the engine-room temperature, and that at the close of such a test it shall stand a 50 per cent. overload for one hour without more than 42·5° C. rise, the construction being such that with an engine-room temperature of 25° C. the insulation will not be injured by the specified rise. The engine is to be compound condensing, with 46-in. and 94-in. cylinders respectively, with a 60-in stroke, running at 75 r.p.m. The building will be laid out to contain six of these units, with the capability of indefinite extension. Six Babcock & Wilcox boilers are on order, with coils for superheating, it being intended to superheat to 120° C. Each boiler has 5,500 sq. ft. of heating surface, and is normally rated at about 550 h.p.

G. W. DE T.

1251. *Electrical Equipment of the Providence, Warren, and Bristol Railway.* (Street Rly. Journ. 19. pp. 181–183, March, 1902.)—This section of the New York, New Haven, and Hartford Railway has recently been changed over from steam to overhead trolley. It has been run for about a year from a temporary station adjoining the new power-house, and containing two 500-kw. 550-volt Westinghouse generators, driven by an old mill engine. It is now used only as an auxiliary during the peak of the load. The new power-house is at Warren, about the centre of the line, and will contain, when complete, two 850-kw., 625-volt General Electric generators, direct-connected to cross-compound condensing Greene engines by the Providence Engineering Company. The boiler-house contains ten 200-h.p. Bridgeport return-tubular boilers, in two batteries. The fire-boxes have steam-jets for burning slack from the engines of the steam section of the line. The Holly gravity system is employed. No separators are employed, extra large curved copper leads being used between the boilers and the main headers, entering the latter from below, while the centre of the engine cylinders are above the water-line in the boilers, the pressure in which is 120 lbs. Dean jet condensers are used. The feeder system is in four sections, so that those nearer the power-station may be run on the 550-volt generators during the load peaks. There is also at each end of the line a 250-cell battery of 800 ampere-hour capacity, made by the Electric Storage Battery Company of Philadelphia. The permanent way has gravel ballast with 70-lb. T-rails of standard A.S.C.E. section, bonded by Washburn & Moen crown pin bonds of the leaf type. Both span and bracket suspension are employed. The old stations are still used, but a number of stops at road-crossings have been added. In spite of this, the schedule time has been improved, for the local trains from Providence to Fall River, from 48 minutes with 14 stops, to 45 minutes with 26 stops, and an express service added, making the run in 33 minutes with 7 stops.

G. W. DE T.

1252. *The Great Northern and City Electric Railway.* (Street Rly. Journ. 19. pp. 200–207, March, 1902.)—This article contains a very full description of the tube-construction work for this railway with illustrations, including drawings showing details of one of the Greathead shields designed for this work by E. W. Moir, a director of the firm of S. Pearson & Sons, the contractors. A brief description is also given of the power-station and of the electric plant to be installed. The line is about 6,200 yards in length, mostly tunnel. The tube is 16 ft. in diameter, except at Moorgate Station, where it is increased to 23 ft. A novelty in construction, introduced after the commencement of the work, consists in making the upper half only of the tube of the ordinary cast-iron segments, the lower half being constructed of Brindle brickwork 15 in. thick, of bricks capable of sustaining a pressure of 400 tons per sq. ft. A cast-iron bearer plate is placed on the line of contact between the cast-iron segments and the brickwork, so as to distribute the pressure equally over the latter. All the machinery required in the construction has been run by means of 20-h.p. Westinghouse 4-pole motors driving a line shaft to which the various machines were belted. The motors were run upon loose pulleys, and put on to the shafting as required. The electric power was obtained from the local supply companies. G. W. DE T.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1253. *Vibration on Tube Railways.* (Engineer, 93. p. 198, Feb. 21, 1902.)—This is the report of a committee composed of Rayleigh, J. W. Barry, and J. A. Ewing addressed to the President of the Board of Trade. A number of witnesses deposed to the annoyance caused by the vibration due to the working of the traffic on the Central London Railway. The committee satisfied themselves that this was the case. A very little experience showed that the disturbances due to successive trains were very unequal, and, as the result of some elaborate observations, the conclusions were arrived at (*a*) that it was a matter of chance whether a given train caused a slight or a severe vibration; (*b*) that trains causing a severe disturbance in one house were as likely as not to cause only slight vibrations in the others; (*c*) that different rooms in the same house were not similarly affected by the same train. In addition, A. Mallock, who was concerned in the details of these investigations, also made observations on the Waterloo and City Railway, the Metropolitan, and a portion of the Great Western Railway. One of the most distinct indications from these records was the responsibility of the locomotive, as distinguished from the coaches, for the worst part of the disturbances, and the attention of the committee was called to the excessive load, unrelieved by springs, carried on each axis of the locomotives. This and the want of rigidity in the rails is the probable cause of the vibration. New types of locomotives were ordered by the railway company in which the unspring-borne part of the load was reduced. In the case of new locomotives, gearing has been introduced, so that the electric machinery is no longer mounted directly on the driving axles. The unspring-borne load is hence reduced from 8 to 2¼ tons on each axle. Motor cars have also been built in which the unspring-borne load on each axle of the truck is under 1¾ tons. With both of these, observations show much less vibration. The committee are hence confident that by adopting motor cars in place of the original locomotives the vibration can be reduced so that no serious annoyance may be caused. On the best form of rail and sleeper they have no decisive evidence. They are disposed to prefer a stiffer rail than that in use on the Central London Railway. W. W. H. G.

1254. *Inertia of Rotating Parts of a Train.* **N. W. Storer.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 153–156, Feb., 1902.)—The author examines the effect of inertia of the wheels and motors of a car, and calculates that for a car weighing 30 tons when loaded, and having eight wheels and two motors of, say, 150 h.p. each, the effect will be equivalent to an increase of the mass of the car by about 10 per cent. H. R. C.

1255. *High-speed Electrical Railways.* **L. v. Reymond-Schiller.** (Zeitschr. Elektrotechn., Wien., 20. pp. 93–99, Feb. 23, 1902.)—In this article, which forms part of a series [see Abstract No. 2306 (1901)], the influence of the air resistance is discussed, and various formulæ are quoted. The effect of the shape of the front of the autocar is also considered. Finally the tractive force is calculated for a train of 200 seats, run at various speeds on lines of different gauges, and it is shown that the broad gauge of 4 m., previously decided upon, is necessary for economical working, especially at the high speed of 250 km. an hour. W. W. H. G.

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[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

1256. *Three-phase Traction System.* **M. Fabre.** (Elektrotechn. Zeitschr. 23. pp. 120–121, Feb. 6, 1902.)—The author shows that with the Ganz system, and the series connection of the induction motors at starting and stopping, the energy recovered by using the motors as brakes may amount to as much as 66 per cent. of the energy wasted in the rheostats at starting. A. H.

1257. *Mechanical Efficiency and Mileage of Electric Automobiles.* **H. W. Alden.** (Elect. World and Engineer, 39. p. 301, Feb. 15, 1902.)—The author has embodied in the accompanying curves data accumulated in the course of several years' experience with respect to the effect of the mechanical efficiency, that is, of motor efficiency and of gearing, bearing and tyre losses. The miles travelled are taken as ordinates, and as abscissæ the values of the energy W in watt-hours required to propel 1,000 lbs. one mile, so that W is determined by the formula—

$$W = \frac{\text{Watts expended}}{\frac{\text{Weight of Vehicle}}{1000} \times \text{Speed in miles per hour.}}$$

In the calculations, each set of determinations was so made that the vehicle speed corresponding to a certain assumed expenditure of energy corresponds exactly to the motor speed at that current, the variations in motor speed being taken from actual tests. In Fig. 1 the continuous lines represent results obtained on level asphalt or macadam, the dotted lines those obtained in congested city traffic and cross-country work. The increase in current

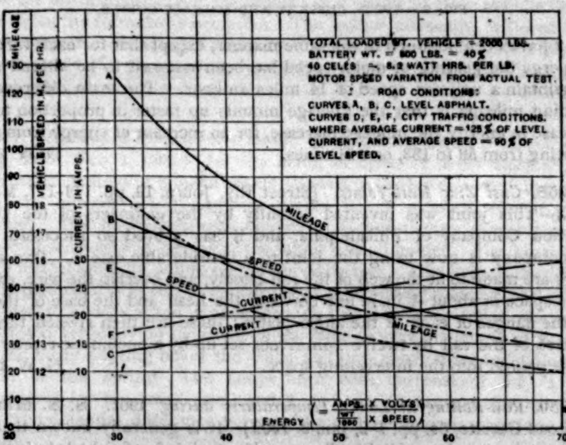


FIG. I.—SPEED, CURRENT AND MILEAGE CURVES.

and reduction in speed under the latter conditions have been found to average 25 and 10 per cent. respectively. The battery capacity has been taken as a variable, depending on the discharge rate, and the range of energy from 30 to 70, the former representing a very low commercial figure, and the latter a prohibitively high one. It will be noticed that a decrease in energy from 60 to 30 increases the mileage from 54 to 126, or 2·33 times. The curves in Fig. 2 have been obtained in the same manner, except that for each variation of energy the gearing or motor-speed has been assumed to be altered so as to maintain a uniform speed of 14 miles an hour. The main difference in resulting mileage is that the mileage mounts up faster in proportion to the decrease in energy, the mileage increase, for an increase of energy from 60 to 30, being from 58 to 133, or 2·51 times. G. W. de T.

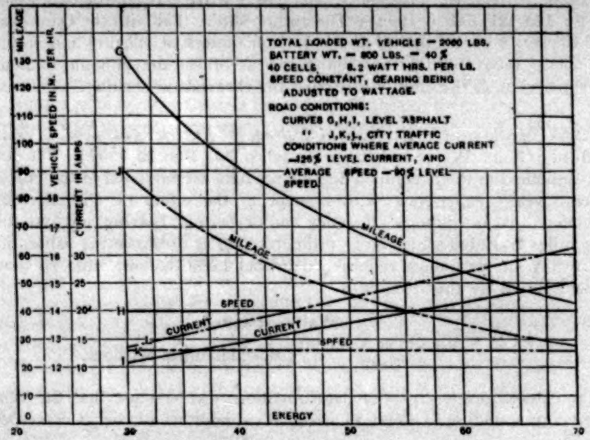


FIG. 2.—SPEED, CURRENT AND MILEAGE CURVES.

1258. *Cast Zinc Rail-Joints.* (Street Rly. Journ. 19. pp. 173–177, March, 1902.)—This joint was invented recently by the engineers of the Union Traction Company of Philadelphia, and it has proved so successful that the company is now using the joint to a considerable extent. Two angle plates are made to fit the web of the rail closely, and overlap the wire, except that a space of about $\frac{3}{16}$ in. is left between the head and the base of the rail and the flanges of each of the angle plates; these are then riveted through the web of the rail by twelve 1-in. rivets, set up by a pneumatic riveter, and zinc is poured into the intervening space. G. W. de T.

1259. *Rail-Rolling at Lower Temperatures during* 1901. **S. S. Martin.** (Railroad Gazette, 34. pp. 1–2, Jan. 3, 1902.)—It is generally known that the non-granular structure of light rails, caused by their being finished at a low temperature, ensures longer and better wear than anything offered by the heavier sections, but it is, nevertheless, only just recently that manufacturers have begun to roll the heavy rail at anything approaching the low temperature used for the other kind. To obtain a non-granular structure it is requisite that the reduction in temperature should take place earlier than has been

heretofore customary, the bar or bloom being rolled direct from the ingot. This would mean delivery of the bloom to the rails at a temperature of 800° C. in place of the 1,000° C., or more, of the reheated bloom. It is important to note that, whilst a rail is held before the final pass at a temperature beyond the critical point it crystallises, and the single pass it afterwards receives is unable to break up the granular structure for more than a certain depth. The method, just introduced, of holding the bar before the last pass, has greatly improved the structure, but even this is not so homogeneous as a structure obtained by direct rolling, the temperature being too much above the critical point, and the steel consequently granulating too easily whilst being held for the cooling before the final pass. Undoubtedly the most satisfactory way of investigating this question of rolling is by means of the microscope. It is thus shown that, to obtain the best structure throughout, the bar must be kept at a lower average temperature. Regarding shrinkage, it is emphatically stated to be not in the least degree helpful or indicative of the construction.
C. E. A.

ELECTRIC LAMPS AND LIGHTING.

1260. *Electric Illumination.* **L. Bell.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 98–115, Feb., 1902.)—In this paper the physiological and physical aspects of lighting are fully discussed. As regards steadiness, the author considers that an alternating current arc worked with a small current density requires a minimum frequency of 100 ∿ per second, the minimum frequency for incandescent lamps being 35 ∿ per second. As regards the intrinsic brilliancy of the radiant employed, the author considers 5 c.-p. per sq. in. as high as it is wise to go for hygienic reasons. When using diffusing globes to reduce the intrinsic brilliancy, the radius r of a spherical globe may be determined from the formula—$r = \text{c.p.}/5\pi$. The author advocates enclosed continuous-current arcs taking 6·5 to 6·75 A. to replace the usual 2,000-c.p. arcs. The colour of light, photometric standards, arrangement of lamps, and other general questions are also discussed.
C. K. F.

1261. *The Benard Enclosed Arc Lamp.* **J. A. Montpellier.** (Électricien, 23. pp. 65–67, Feb. 1, 1902.)—In this lamp, in order to avoid shadows, the lower carbon is held in a metal socket secured in the lower end of the inner globe, the current being supplied thereto by an external wire of small diameter. The feed-mechanism comprises a central core movable in the regulating solenoid and serving as the upper carbon holder. The brake consists of a steel knife for acting on the upper carbon. This knife is carried by a lever pivoted at one end to the core of the regulating solenoid, and at the other end to a vertical rod passing through a guide eye or collar which can be adjusted vertically on the frame of the lamp to vary the length of the arc. This rod bears a spring below the collar and nuts above it for regulating the tension of the spring. The lamps burn with currents of 1·5, 2, and 2·5 amperes for the small size; and 3, 4, 5, and 6 amperes for the large size. The potential difference between the carbons is preferably from 75 to 80 volts.
C. K. F.

1262. *The Nernst Lamp.* **A. J. Wurts.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 254–270, March, 1902; Discussion.)—The discussion elicited the following facts. Filaments can be made from a variety of substances, but the most refractory substances cannot be used, owing to the fact that they require a large steadying resistance, and are electrically unstable. The curve for such filaments shows that they would have to be worked at a point where the voltage decreases with increasing current, and their commercial efficiency is small. The platinum used in a 6-filament lamp, as made in America, costs about 92 cents. On direct-current, lamps usually break at one of the terminals, where platinum black is deposited in the pores. In America no attempts have yet been made to produce a lamp of less than 50-c.p.; lamps of 25-c.p., made in Germany, are said to be too delicate for ordinary use. The nature of the black deposit on the filament, when worked with direct-current, is not very certain, but it is believed to be platinum black. The filaments are run at a temperature of about 2,500° C. Irrespective of the discoloration of the globes and porcelain parts of the lamp, the candle-power given out by the filament decreases by about 3 per cent. in the first 100 hours; but this loss is small compared with the loss in the lamp when it is neglected and not properly cleaned. The shrinkage of the filament has been provided for by making it U-shaped. A life of 300 hours has been obtained with filaments lighted by direct current, and it is possible that this may eventually be increased to 500 hours. The Nernst lamp burns well on 25 cycles, and no difference is noticeable between 25 and 60 cycles. The cut-out is, however, apt to rattle on the lower frequency. If a filament is too long and heavy, it will sag at the running temperature; but if properly proportioned, it will remain almost perfectly straight. [See also Abstract No. 2312 (1901).]

W. H. S.

REFERENCES.

1263. *Gmünd Electricity Works.* **E. v. Rziha.** (Zeitschr. Elektrotechn., Wien, 20. pp. 46–49, Jan. 26, 1902.)—Description of a small station worked by gas engines, supplied with Dowson gas, and containing two 40-kw. dynamos. W. H. S.

1264. *Cost of Tramway Construction in France.* (Tram. Rly. World, 11. pp. 19–22, Jan., 1902.)—This paper consists of valuable tabulated data relative to the construction costs of French tramways. The systems considered are: Horse traction; Rowan, steam; Serpollet, steam; Compressed Air; Hot Water Engine (Lamm and Francq system); Accumulator; Overhead Wire; Conduit; and the Diatto and Claret-Vuilleumier surface-contact systems. G. W. de T.

TELEGRAPHY AND TELEPHONY.

1265. *Gruhn's Telautograph.* **Gruhn.** (Elektrotechn. Zeitschr. **23.** pp. 117–119; Discussion, pp. 119–120, Feb. 6, 1902. Paper read before the Elektrotechn. Verein, Dec. 17, 1901.)—In this apparatus the arrangement for resolving the motion of the writing pencil into two components is similar to Gray's. In the new apparatus, however, direct currents varying continuously in strength in proportion to the distance of the pencil-point from each edge of the writing surface are employed. This is effected by two regulating resistances which are both connected across the terminals of a battery having one pole earthed. Over each of these resistances slides a contact which receives one component of the motion of the pencil through a connecting rod, and is connected to one of the two line wires. The receiver consists of a mirror which can oscillate in two directions at right-angles to each other, and controlled by two electromagnets, one for each line wire. This mirror reflects a ray of light from a glow lamp on to a sensitised band of paper. The operation is as follows: As soon as the sender has grasped the pencil the battery at the transmitting station is automatically switched into circuit, and the glow lamp at the receiving station, with its battery, switched into circuit through a relay. When the sender returns the pencil to its position of rest the same relay extinguishes the glow lamp and sets the electromotor in motion to feed the sensitised paper bearing the record out of the box through a developing and fixing tank. The motor automatically switches itself out of circuit when the required length of paper has been fed. In order to prevent successive words from being connected by a useless line the following arrangement is adopted, viz.: On the pencil of the transmitter is mounted a switch, which is closed when the pencil is pressing on the writing surface, and is open when the pencil is raised. Through this switch flows one "component" current, and as soon as this current is interrupted the beam of light at the receiver moves rapidly to the edge of the writing surface, and thus there is no photographic print. When the pencil again presses on the writing surface the switch is closed and the beam of light returns to its correct position. By making the apparatus with a resistance of 6,000 ohms the influence of the resistance of the line in reducing the size of the record at the receiver is rendered negligible. The motor for effecting the paper-feed at the receiver will work with a current of 0·2 amperes at 4 volts, which is supplied by dry batteries. These batteries also supply the glow lamp. In the discussion **von Hefner-Alteneck** pointed out that the receiver was very similar to the Pollák-Virág apparatus, and expressed doubts as to the suitability of the apparatus for use on very long lines, as did **Strecker**.

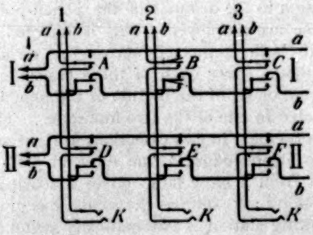
C. K. F.

1266. *Wireless Telegraphy. German Post Office Test of Braun's System.* **Jentsch.** (Archiv Post Tele. 24. pp. 763–766, Dec., 1901.)—Description of an experimental installation between Cuxhaven and Heligoland. The transmitter gives out trains of waves of a definite frequency to which the receiver is also tuned by suitable capacities and self-inductions. The aerial wire is one quarter wave-length.

Good results were obtained with a 40 m. aerial. The coherer was one of

Siemens and Halske's with steel electrodes and steel filings. Very satisfactory results were obtained, the speed being about seven words per minute.
J. E.-M.

1267. *Janus Telephone Exchange System.* **H. Zopke.** (Elektrotechn. Zeitschr. 23. pp. 151–157, Feb. 20, 1902.)—This system enables the instruments of a private network, such as that in a large manufactory, to be also used as postal exchange instruments. It consists of a non-automatic secondary exchange, the connections being as follows: I *a b* and II *a b* are the postal lines, and 1 *a b*, 2 *a b*, 3 *a b* the private lines; A, B, C, . . . are Janus switches, the spring tongues of which are displaced outwardly by a conical insulating plug mounted on a spindle which moves in guides, and is provided with a handle; this spindle is provided with a bayonet-fastening or like-locking device so as to enable the tongues to be held in their outward positions as at B. K, K are the ordinary jacks for the private exchange. This type of switch is modified when there are a large number of postal lines, in which case the conical plug is actuated by a crank-arm. A somewhat similar switch is used for connecting the calling-up apparatus either to the postal lines or to the private lines as required. Full diagrams are given of the connections of all the apparatus, together with its method of operation and its application to several cases. It is made by Messrs. Mix & Genest, of Berlin. C. K. F.



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1268. *Wireless Telegraphy.* **A. Slaby.** (Zeitschr. Vereines Deutsch. Ing. 45. pp. 1047–1055, July 27, 1901. Abstract in the Electrician, Aug. 23, 1901.)—The paper contains a description, in popular form, of Marconi's and other systems of wireless telegraphy. Some modifications introduced by the author are described in detail.
J. E.-M.

1269. *Wireless Telegraphy.* **F. Braun.** (Phys. Zeitschr. 3. pp. 143–148; Discussion, p. 148, Jan. 1, 1902. Paper read before the 73rd Naturforscherversammlung at Hamburg, Sept. 24, 1901.)—A discourse on wireless telegraphy, illustrated by experiments. E. H. B.

1270. *Automatic Telephone Exchange at Fall River.* (Elect. Rev. N.Y. 39. pp. 604–606, Nov. 16, 1901.)—Description of the Automatic Telephone Exchange at Fall River, Mass., U.S.A. J. E. K.